A LEARNED TREATISE OF Globes,

Both Cœleſtiall and *Terreſtriall: with their* ſeverall uſes.

Written firſt in Latine, by Mr *Robert Hues*: and by him ſo Publiſhed.

Afterward Illuſtrated with Notes, by Io. Iſa. PONTANUS.

And now laſtly made Engliſh, for the benefit of the Vnlearned.

By *John Chilmead* Mr *A. of* Chriſt-Church in OXON.

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To the Reader.

THat nothing is at once brought forth, and perfected, is an observation wee may make, as from other things, so in a more especiall manner from Arts and Sciences. For (not to speake any thing of the rest, which yet have all of them in succession of times, had their accessions of Perfection) if wee but take the Astronomicall writings of Aratus, or of Eudoxus, (according to whose observations Aratus is reported by Leontius Mechanicus to have composed his Phænomena) and compare the same with the later writings of Ptolomy; what errours and imperfections shall wee meet withall? And in the Geographicall workes of the Ancients, whether we compare them among themselves, the later with the former; or either of them with the more accurate descriptions of our Moderne Geographers: how many things shal we meet withall therein, that need either to be corrected as erroneous, or else

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ſupplied as defective? There ſhall wee finde Strabo *every where harſhly cenſuring the extravagancies of* Eratoſthenes, Hipparchus, Polybius, *and* Poſidonius; *Authors among the Ancients of very high eſteeme. For as for* Pytheas, Euthemeres, Antiphanes, *& thoſe Indian Hiſtoriographers,* Megaſthenes, Nearchus, *and* Daimachus, *whoſe writings are ſtuffed with ſo many fabulous idle relations, he accounts them unworthy his cenſure. In like manner* Marinus Tyrius, *however a moſt diligent Writer, is yet hardly dealt withall by* Ptolomy. *And even* Ptolomy *himſelfe, a man that for his great knowledge and experience may ſeeme to have excelled all thoſe that went before him: yet if a man ſhall but compare his Geographicall Tables with the more perfect diſcoveries of our later times: what defects and imperfections ſhall hee there diſcover? Who ſees not his errours in the bounds he ſets to the Southerne parts of* Aſia *and* Africa? *How imperfect are his deſcriptions of the Northerne Coaſts of* Europe? *Theſe errours of* Ptolomy, *and of the Ancient Geographers, have now at length beene diſcovered by the late Sea voyages of the* Portugalls, *and* Engliſh: *the Southerne Coaſts of* Africa *and*

Aſia,

Asia, *having beene most diligently searched into by the* Portugalls; *as the Northerne parts of* Europe, *have in like manner beene by our owne Country-men. Among whom, the first that adventured on the discovery of these parts, were,* Sir Hugh Willoughby, *and* Richard Chanceler: *after them,* Stephen Borough. *And farther yet then either of these, did* Arthur Pet, *and* Charles Iackman *discover these parts. And these voyages were all undertaken by the instigation of* Sebastian Cabot: *that so, if it were possible, there might bee found out a nearer passage to* Cathay *and* China: *yet all in vaine; save only that by this meanes a course of trafficke was confirmed betwixt us and the* Moscovite.

When their attempts succeeded not this way; their next designe was then to try, what might bee done on the Northerne Coasts of America: *and the first undertaker of these voyages was* Mr. nartin Frobisher: *who was afterward seconded by* Mr. Iohn Davis. *By meanes of all which Navigations, many errours of the Ancients, and their great ignorance was discovered.*

But now that all these their endeavours succeeded not, our Kingdome at that time

being well furniſhed in ſhips, and impatient of idleneſſe: they reſolved at length to adventure upon other parts. And firſt Sir Humphry Gilbert *with great courage and Forces attempted to make a diſcovery of thoſe parts of* America, *which were yet unknowne to the* Spaniard: *but the ſucceſſe was not anſwerable. Which attempt of his, was afterward more proſperouſly proſecuted by that honourable Gentleman* Sir Walter Rawleigh: *by whoſe meanes* Virginia *was firſt diſcovered unto us, the Generall of his Forces being* Sir Richard Greenvile: *which Countrey was afterwards very exactly ſurveighed and deſcribed by* Mr. Thomas Harriot.

Neither have our Countrey-men within theſe limits bounded their Navigations. For Sir Francis Drake, *paſſing through the ſtraites of* Magellane, *and bearing up along the Weſterne Coaſts of* America, *diſcovered as farre as* 50. *degrees of Northerne Latitude. After whom,* Mr. Thomas Candiſh *tracing the ſame ſteps, hath purchaſed himſelfe as large a monument of his fame with all ſucceeding ages. I ſhall not need to reckon with theſe our Countreyman* Sir Iohn Mandevil, *who almoſt* 300. *yeares ſince, in a* 33. *yeares voyage by land, tooke a ſtrict*

view

view of all India, China, Tartary *and* Persia, *with the Regions adjoyning.*

By these, and the like expeditions by Sea, the matter is brought to that passe, that our English *Nation may seeme to contend even with the* Spaniard *and* Portugall *himselfe, for the glory of Navigation. And without all doubt, had they but taken along with them a very reasonable competency of skill in Geometry, and Astronomy: they had by this gotten themselves a farre more honourable name at Sea, then they. And indeed, it is the opinion of many understanding men, that their endeavours have taken the lesse effect, meerely through ignorance in these Sciences. That therfore there might be some small accrument to their study and paines, that take delight in these Arts; I have composed this small Treatise: which that it may be for their profit, I earnestly desire.* Farewell.

The Contents of the Chapters of this TREATISE.

THe Preface: wherein is ſhewed the Antiquity, and excellency of *Globes*, in compariſon of all other Inſtruments, as being of a forme moſt apt to expreſſe the figure of the Heavens and Earth. The roundnes of the Earth is defended againſt *Patricius*. The height of Hilles, how much it may detract from the roundneſſe of the Earth.

The firſt PART.

Chapter 1.

WHat a *Globe* is, with the parts thereof; and of the Circles without the *Globe*: What the Horizon is, with the things deſcribed thereon in a Materiall *Globe*. What the Meridian is, the Poles, and *Axis*; as alſo the Houre-circle and Index.

Chap. 2.

Of the circles which are deſcribed on the ſuperficies of *Globes*. Of the *Æquator* or *Æquinoctiall* circle. What a day is, both Naturall, and Artificiall: as alſo of Houres, both

both Equall, and Vnequall. Of the Zodiacke, and Eccliptick. What a yeare is, and the Indeterminate limits thereof: together with the diverſe opinions of Authors concerning the ſame; as alſo many of their errours. What the *Æquinoctium*, and Solſtices are; with changing of their places, and Anticipation in the Calendar, confirmed by many obſervations. The errour of *Soſigenes*, and *Iulius Cæſar*, in deſigning the place of the *Æquinoctium*. Of the Colures. The longitude and latitude of the fixed Starres are proved by obſervations, to have beene altered. A place of *Ptolomy*, *lib.* 1. *cap.* 7. *Geograph.* is vindicated from the injury of his interpreters, and confirmed by the authority of *Strabo*. Of the Tropickes: with the changing of their declination. What the Arcticke and Antarcticke Circles are: Of the Verticall Circles, and Quadrant of Altitude.

Chap. 3.

Of the three poſitions of Sphere, Right, Parallel, and Oblique: with their ſeverall affections.

Chap. 4.

Of the Zones, and their number. The vaine opinions of the Ancients, concerning the temperature of the Zones, are rejected; both by the Teſtimonies of ſome of the Ancients themſelves, as alſo by the experience of later times.

Chap. 5.

Of the *Amphiſcij*, *Periſcij*, and *Heteroſcij*.

Chap.

Chap. 6.

Of the *Periæci*, *Antœci*, and *Antipodes*, compared to each other.

Chap. 7.

Of Climates, and Parallels.

The ſecond PART.

Chap. 1.

OF ſuch things as are proper to the Cœleſtiall *Globe*: as namely of the Stars. And firſt of the Planets, or wandring Stars.

Chap. 2.

Of the fixed Starres, and their Conſtellations.

Chap. 3.

Of the Conſtellations of the Northerne Hemiſphære.

Chap. 4.

The ſignes of the Zodiacke; and firſt of the Northerne.

Chap. 5.

The Conſtellations of the Southerne Hemiſphære: and firſt of thoſe in the Zodiacke.

Chap. 6.

Of the reſt of the Conſtellations of the Southerne Hemiſphære.

Chap. 7.

Of the other Stars which are not expreſſed in *Globes*. Why the Stars appeare ſometimes in greater number, then at other times, and ſometimes greater, and at other times leſſe: with

with the confutation of ſome vaine opinions concerning the ſame. The idle relations of *Americus Veſpuſius*, *Cardan*, and *Patricius*, concerning the extraordiny greatneſſe of the Stars about the South Pole, are refuted out of the Authors owne experience.

The third PART.

Chap. 1.

THe Geographicall deſcription of the Terreſtriall *Globe*, with the parts of the world that are yet knowne. The errours of *Ptolomy*, concerning the Southerne bounds of *Africa* and *Aſia*, as alſo of the Northerne limits of *Europe*, are condemned, out of the Writings of the Ancients, and various experience of later Writers.

Chap. 2.

Of the compaſſe of the Earth, and the meaſure of a Degree: with diverſe opinions concerning the ſame of the *Greekes*; as namely, *Eratoſthenes*, *Hipparchus*, *Poſidonius*, *Cleomedes*, and *Ptolomy*: as alſo of the *Arabians*, *Italians*, *Germans*, *Engliſh*, and *Spaniſh*. *Poſidonius*, and *Eratoſthenes* are confuted out of their owne obſervations and propoſitions. *Ptolomyes* opinion is preferred before the reſt, and he freed from the Calumnies of *Maurolycus*: who is alſo taxed, in that without cauſe favouring *Poſidonius*, he unjuſtly condemnes *Ptolomy*.

The

The Fourth PART.

Chap. 1.

HOw to finde out the longitude, latitude, diſtance, and angle of poſition or ſituation of any places expreſſed in the Terreſtriall *Globe.*

Chap. 2.

Of the Latitude of any place.

Chap. 3.

How to finde the diſtance, and angle of poſition of any two places.

Chap. 4.

To finde the Altitude of the Sunne, or Starres.

Chap. 5.

To finde the place and declination of the Sunne for any day given.

Chap. 6.

To finde the Latitude of any place, by obſerving the Meridian altitude of the Sunne, or Starres.

Chap. 7.

How to find the Right and Oblique Aſcenſion of the Sunne, and Stars, for any Latitude of Place and Time.

Chap. 8.

How to find the Horizontall difference betwixt the Meridian and the verticall circle of the Sunne, or any other Starre, which they call the *Azimuth*, for any time, or place aſſigned.

Chap.

Chap. 9.

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Chap. 10.

Of the threefold riſing and ſetting of Stars.

Chap. 11.

How to finde the beginning and end of the Twilight, for any latitude of place and time.

Chap. 12.

To find for any latitude of place, and time, the length of the Artificiall day, or night; or the quantity of the Sunnes Parallel that remaines above the Horizon, and that is hid beneath it: and to performe the ſame by any other Starre.

Chap. 13.

To finde the houre of the Day and Night, both Equall and Vnequall, for any time and latitude of place.

Chap. 14.

To finde the longitude, latitude, and declination of the fixed Stars, as they are expreſſed in the *Globe*.

Chap. 15.

To find the declination of the Needle from the true Meridian, which they commonly call, *the Variation of the Compaſſe*, for any latitude aſſigned: Where the errours of thoſe are diſcovered, who aſſigne to the Magneticall Needle a certaine Meridian, and fixed point which it alwayes reſpects; and that affirme this change of variation to be regular. All which vaine

vaine conjectures of theirs, and ungrounded Hypotheſes, are refuted both by more certaine obſervations of others, as alſo of the Author himſelfe.

Chap. 16.

How to make a Sun Diall, by the helpe of the *Globe*, for any latitude of place.

The fifth and laſt PART.

OF the *Rumbes* that are deſcribed upon the Terreſtriall *Globe*: wherein their nature, Originall, and uſe in Navigation is declared.

The

The Preface.

THere are two kinds of Inſtruments, by which Artificers have conceived, that the figure of this ſo beautifull and various fabricke of the whole Univerſe, might moſt aptly be expreſſed, and, as it were, at once preſented to the view. The one, exhibiting this Idea in a round ſolid, is called a Globe, or Sphære: The other, expreſſing the ſame in a Plaine, they tearme a Planiſphære, or Map. Both of which having been long ſince invented by the Ancients, have yet even to our times in a continued ſucceſſion, received ſtill more ripeneſſe and perfection. The Sphære or Globe, and the uſe thereof, is reported by Diodorus Siculus to have been firſt found out by Atlas of Libya: Whence afterward ſprung the Fable of his bearing up the Heavens with his ſhoulders. Others attribute the invention of the ſame to Thales. And it was afterward brought to perfection by Crates, (of whom Strabo makes mention) Archimedes, and Proclus; but moſt of all by Ptolomy; according to whoſe rules and obſervations eſpecially, ſucceeding times compoſed their Globes, as Leontius Mechanicus affirmes. And now there hath been much perfe-

ction added to the ſame in theſe our later times, by the induſtry and diligence of Gemma Friſius, and Gerardus Mercator; as it may appeare by thoſe Globes that were ſet forth at London, Anno 1593. ſo that now there ſeemes not to be any thing that may be added to them. The Planiſphære indeed is a fine invention, and hath in it wonderfull varietie of workmanſhip, if ſo be that the compoſition of it be rightly deduced out of Geometricall and Opticall principles: and it wants not its great delightfulneſſe, and beauty alſo. But yet that Other, being the more ancient, hath alſo the priority in Nature, and is of the moſt conuenient forme; and therefore more aptly accommodated for the underſtanding and fancy, (not to ſpeake any thing of the beauty and gracefulneſſe of it) for it repreſenteth the things themſelves in proper genuine figures. For as concerning the figure of the Heavens, whether it were round, was ſcarcely euer queſtioned by any. So likewiſe touching the figure of the Earth, notwithſtanding many and ſundry opinions have been broached among the ancient Philoſophers, ſome of them contending for a plaine, others an hollow, others a Cubicall, and ſome a Pyramidall forme: yet this opinion of its Roundneſſe, with greateſt conſent of reaſon at length prevailed, the reſt being all exploded. Now we affirme it to be round, yet ſo, as that wee alſo admit of its inequalities, by reaſon of thoſe ſo great eminencies of hilles, and depreſſion of vallies. Eratoſthenes, as he is cited by Strabo in his firſt booke, ſaith, that the faſhion of the earth is like that of a Globe, not ſo exactly round as an artificiall Globe

Strabo lib. 1. Geogt.

is,

is, but that it hath certaine inequalities. The earth cannot be ſaid to be of an exact orbicular forme, by reaſon of ſo many high hilles, and low plaines: as Pliny *rightly obſerues. And* Strabo *alſo in his first book of his* Geography, *ſaith, that the Earth and the Water together make up one ſpharicall body, not of ſo exact a forme, as that of the Heavens; although not much unlike it. This aſſertion of the roundneſſe of the Earth, with the intervening Sea, is confirmed alſo by theſe reaſons. For firſt, that it is round from Eaſt to Weſt is proved by the Sun, Moon, and the other Starres, which are ſeen to riſe and ſet firſt with thoſe that inhabite more Eaſtwardly, and afterward with them that are farther Weſt. The Sun riſeth with the* Perſians *that dwell in the Eaſterne parts, foure houres ſooner then it doth with thoſe that dwell in* Spaine *more Weſtward: as* Cleomedes *affirmes. The ſame is alſo proved by the obſerving of Eclipſes, eſpecially thoſe of the Moon; which although they happen at the ſame time, are not yet obſerved in all places at the ſame houre of the day or night, but the houre of their appearing is later with them that inhabite Eaſtward, then it is with the more Weſterne people. An Eclipſe of the Moon, which* Ptolomy *reports* lib. 1. Geogr. cap. 4. *to have been ſeen in* Arbela, (*a towne in* Aſſyria,) *at the fifth houre of the night; the ſame was obſerued at* Carthage *at the ſecond houre. In like manner an Eclipſe of the Sun, which was obſerved in* Campania *to be betwixt 7 and 8 of the clock; was ſeen by* Corbulo, *a Captaine in* Armenia, *betwixt 10 and 11. as it is related by* Pliny. *Now that it is alſo*

Pliny lib 2. cap. 21.

Cleomed. lib 1. cap 8.

Ptolom. Geog. lib 1 cap. 4.

Plin. lib. 7. c. p. 76.

alſo of a ſphæricall figure from North to South, may be clearly demonſtrated by the riſings, ſettings, elevations and depreſſions of the Starres and Poles. The bright ſtarre that ſhines ſo reſplendently in the upper part of the ſterne of the Ship Argo, *and is called by the* Greekes κάνωπος, *is ſcarcely to be ſeen at all in* Rhodes, *unleſſe it be from ſome eminent high place: yet the ſame is ſeen very plainly in* Alexandria, *as being elevated above the Horizon about the fourth part of a ſigne: as* Proclus *affirmes in the end of his book* de Sphæra. *For I read it,* Conſpicuè cernitur; *not as it is commonly,* Prorſus non cernitur: *notwithſtanding that both the Greek text, and alſo the Latine tranſlation are againſt it. Another argument may be taken from the figure of the ſhadow in the Eclipſe of the Moon, cauſed by the interpoſition of the Earths opacous body: Which ſhadow being ſphæricall, cannot proceed from any other then a round globous body: as it is demonſtrated unto us out of Opticall principles. But this one reaſon is beyond all exception: that thoſe that make toward the land at Sea, ſhall firſt of all deſcry the tops of the hilles onely, and afterward, as they draw nearer to ſhore, they ſee the lower parts of the ſame by little and little: Which cannot proceed from any other cauſe, then the gibboſitie of the Earths ſuperficies.*

As for thoſe other opinions of the hollow, Cubicall, Pyramidall, and plaine figure of the Earth, you have them all largely examined both in Theon, (Ptolomies *Interpreter*) Cleomedes, *and almoſt in all our ordinary authours of the Sphære;*

together

together with the reasons why they are rejected. Yet that old conceit of the plainnesse of the Earths superficies, is againe now at last, tanquam Crambe recocta, *set forth in a new dresse, and thrust upon us by* Franciscus Patricius; *Who by some few cold arguments, & misunderstood experiments, endeavours to confirme his owne, and consequently to overthrow that other received opinion of the sphæricall figure of the Earth. I shall onely lightly touch at his chiefest arguments; my present purpose and intention suffering me not to insist long on the confutation of them. And first of all, the great height of hilles, and the depression of vallies, so much disagreeing from the evennesse of the plain parts of the Earth, seem to make very much against the roundnesse of the Earth. Who can heare with patience, saith he, that those huge high mountaines of* Norway, *or the mountaine* Slotus, *which lies under the Pole, and is the highest in the world, should yet be thought to have the same superficies with the Sea lying beneath it? This therfore being the chiefest reason, that may seem to overthrow the opinion of the Earth and Seas making up one sphæricall body; let us examine it a little more nearly, and consider, how great this inequalitie may be, that seemes to make so much against the evennesse of this Terrestriall Globe. Many strange, and almost incredible things are reported by* Aristotle, Mela, Pliny, *and* Solinus, *of the unusuall height of* Athos, *an hill in* Macedonia, *and of* Casius *in* Syria, *as also of another of the same name in* Arabia, *and of the mountaine* Caucasus. *And among the rest, one of the most mi-*

raculous things which they have observed of the mountaine Athos, is, that whereas it is situate in Macedony, it casts a shadow into the market place at Myrrhina, a towne in the Iland Lemnos; from whence Athos is distant 86. miles. But for as much as Athos lies Westward from Lemnos, as may appeare out of Ptolomies Tables, no marvaile that it casts so large a shadow: seeing that wee may observe by daily experience, that as well when the Sun riseth, as when it sets, the shadowes are alwayes extraordinary long. But that which Pliny, and Solinus report of the same mountaine, I should rather account among the rest of their fabulous Stories; where as they affirme it to be so high, that it is thought to be above that region of the aire, whence the raine is wont to fall. And this opinion (say they) was first grounded upon a report that there goes, that the ashes which are left upon the Altars on the top of this hill, are never washed away, but are found remaining in heapes upon the same. To this may be added another testimony, out of the Excerpts of the seventh booke of Strabo, where it is said, that those that inhabite the top of this mountaine, doe see the Sun three houres sooner, then those that live neare the Sea side. The height of the mountaine Caucasus is in like manner celebrated by Aristotle, the top whereof is enlightned by the Sunnes beames the third part of the night both morning and evening. No lesse fabulous is that which is reported by Pliny and Solinus of Casius in Syria, from whose top the Sun rising is discovered about the fourth watch of the night: which is also related by Mela of that

other

other Caſius *in* Arabia. *But that all theſe relations are no other then meere fables, is acutely and ſolidly proved by* Petrus Nonius, *out of the very principles of Geometry. As for that which* Euſtathius *writes, that* Hercules *pillars, called by the Greeks* Calpe *and* Abenna, *are celebrated by* Dionyſius Periegetes *for their miraculous height, is plainly abſurd and ridiculous. For theſe ariſe not above an hundred elles in height, which is but a furlong: whereas the* Pyramids *of* Egypt *are reported by* Strabo *to equall that height; and ſome trees in* India *are found to exceed it: if wee may credit the relations of thoſe Writers, who in the ſame* Strabo *affirme, that there growes a tree by the river* Hyarotis, *that caſteth a ſhadow at noon five furlongs long.*

Thoſe fabulous narrations of the Ancients, are ſeconded by as vaine reports of our moderne times. And firſt of all Scaliger *writes, from other mens relation, that* Tenariff, *one of the* Canary *Iſlands, riſeth in height fifteene leagues, which amount to above ſixtie miles. But* Patricius *not content with this meaſure, ſtretcheth it to ſeventie miles. There are other hilles in like manner cryed up for their great height; as namely the mountaine* Andi *in* Peru, *and another in the Iſle* Pico *among the* Azores *Iſlands: but yet both theſe fall ſhort of* Tenariff. *What credit theſe relations may deſerve, we will now examine. And firſt for* Tenariff, *it is reported by many writers to be of ſo great a height, that it is probable the whole world affoardes not a more eminent place; not excepting the mountaine* Slotus *it ſelfe; which whether ever any other mor-*

tall man hath ſeen, beſides that Monke of Oxford *(who by his skill in Magicke conveighed himſelfe into the utmoſt Northerne regions, and tooke a view of all the places about the Pole, (as the Story hath it) is more then I am able to determine. Yet that this Iſle cannot be ſo high as* Scaliger *would have it, we may be the more bold to beleeve, becauſe that the tops of it are ſcarcely ever free from ſnow: ſo that you ſhall have them covered all over with ſnow all the yeare long, ſave onely one, or, at the moſt, two moneths in the midſt of ſummer: as may appeare out of the* Spaniſh *Writers. Now that any ſnow is generated 60 or 70 miles above the plaine ſuperficies of the Earth and Water, is more then they will ever perſwade us: ſeeing that the higheſt vapours never riſe above 48 miles above the Earth, according to* Eratoſthenes *his meaſure; but according to* Ptolomy, *they aſcend not above 41 miles. Notwithſtanding* Cardan, *and ſome other profeſt Mathematicians, are bold to raiſe them up to 288 miles; but with no ſmall ſtaine of their name have they mixed thoſe trifles with their other writings.* Solinus *reports that the tops of the mountaine* Atlas *reacheth very neare as high as the circle of the Moon: but he betrayeth his own errour, in that he confeſſeth that the top of it is covered with ſnow, and ſhineth with fires in the night. Not unlike to this, are thoſe things which are reported of the ſame mountaine, and its height, by* Herodotus, Dionyſius Afer, *and his ſcholiaſt* Euſtathius: *whence it is called in Authours,* Cœlorum columen, *the pillar that beares up the Heavens.*

But

But to let paſſe theſe vaine prodigious relations: let us come to thoſe things that ſeem to cary a greater ſhew of truth. Eratoſthenes *found by Dioptricall inſtruments, and meaſuring the diſtances betwixt the places of his obſervation, that a perpendicular, drawen from the top of the higheſt mountaine, downe to the loweſt bottome or vally, did not exceed ten furlongs.* Cleomedes *ſaith, that there is no hill found to be above fifteene furlongs in height: and ſo high as this, was that vaſt ſteepe rocke in* Bactriana, *which is called* Siſimitræ Petra, *mentioned by* Strabo *in the* 11. *booke of his* Geography. *The toppes of the* Theſſalian *mountaines are raiſed to a greater height by* Solinus, *then ever it is poſſible for any hill to reach. Yet if we may beleeve* Pliny, Dicæarchus *being employed by the Kings command in the ſame buſineſſe, found that the height of* Pelion, *which is the higheſt of all, exceeded not* 1250. *paſes, which is but ten furlongs. But to proceed yet a little further, leaſt we ſhould ſeem too ſparing herein, and to reſtraine them within narrower limits then wee ought: wee will adde to the height of hilles, the depth alſo of the Sea. Of which the illuſtrious* Iulius Scaliger *in his* 38. *Exercitation againſt* Cardan, *writeth thus. The depth of the Sea (ſaith he) is not very great: for it ſeldome exceeds* 80. *paſes, in moſt places it is not* 20. *paſes, and in many places not above* 6. *in few places it reacheth* 100. *paſes, and very ſeldome, or never exceeds this number. But becauſe that this falles very far ſhort of the truth, as is teſtified by the daily experience of thoſe that paſſe the Seas: let us make the depth of*

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the Sea equall to the height of mountaines: ſo that ſuppoſe the depth thereof to be 10. *furlongs, which is the meaſure of the* Sardinian *Sea, in the deepeſt places as* Poſidonius *in* Strabo *affirmes. Or if you pleaſe, let it be* 15. *furlongs, as* Cleomedes, *and* Fabianus, *cited by* Pliny lib. 2. c. 102. *will have it. (For* Georg. Valla *in his interpretation of* Cleomedes, *deales not fairely with his authour, where he makes him aſſigne* 30. *furlongs to be the meaſure of the Seas depth.) Theſe grounds being thus laid, let us now ſee what proportion the height of hilles may beare to the Diameter of the whole Earth: that ſo we may hence gather, that the extuberancy of hilles are able to detract little or nothing from the roundneſſe of the Earth; but that this excreſcency will be but like a little knob or duſt upon a ball, as* Cleomedes *ſaith. For if wee ſuppoſe the circumference of the whole earth to be* 180000. *furlongs, according to* Ptolomies *account, (neither did ever any of the Ancients aſſigne a leſſe meaſure then this; as* Strabo *witneſſeth:) the Diameter thereof will be, (according to the proportion betwixt a circle and its Diameter found out by* Archimedes, *) above* 57272. *furlongs. If then wee grant the higheſt hilles to be ten furlongs high, according to* Eratoſthenes *and* Dicæarchus; *they will beare the ſame proportion to the Diameter of the Earth, that is, betwixt* 1. *and* 5727. (Peucerus *miſtakes himſelfe, when he ſaith, that the Diameter of the Earth to the perpendicular of ten furlongs is, as* 18000. *to* 1. *for this is the proportion it beareth to the whole circumference, and*

not

not the Diameter. Or ſuppoſe the toppes of the higheſt hilles to aſcend to the perpendicular of fifteene furlongs, as Cleomedes *would have it: the proportion then will be of one to* 3818. *Or if you pleaſe, let it be thirtie furlongs, of which height is a certaine rocke in* Sogdiana, *ſpoken of by* Strabo, *in the eleventh Booke of his* Geography, *(notwithſtanding* Cleomedes *is of opinion, that a perpendicular drawne from the top of the higheſt hill, to the bottome of the deepeſt Sea, exceeds not this meaſure:) the proportion will be no greater, then of one to* 1908. *Or let us extend it yet farther, if you will, to foure miles, or thirty-two furlongs, (of which height the mountaine* Caſius *in* Syria *is reported by* Pliny *to be,) the proportion will yet be ſomewhat leſſe then of one to* 1789. *I am therefore ſo farre from giving any credit to* Patricius *his relation of* Tenariffes *being ſeventy-two miles high, (unleſſe it be meaſured by many oblique and crooked turnings and windings: in which manner* Pliny *meaſureth the height of the* Alpes *alſo to be fiftie miles;) as that I cannot aſſent to* Alhazen, *an* Arabian, *who would have the toppes of the higheſt hilles to reach to eight* Arabian *miles, or eighty furlongs, as I thinke: neither yet to* Pliny, *who in his* quarto lib. cap. 11. *affirmes the mountaine* Hæmus *to be ſix miles in height: and I can ſcarcely yeeld to the ſame* Pliny, *when as he ſpeakes of other hilles foure miles in height. And whoſoever ſhould affirme any hill to be higher then this, though it were* Mercury *himſelfe, I ſhould hardly*

hardly beleeve him. Thus much of the height of hilles, which ſeemed to derogate from the roundneſſe of the Terreſtriall Globe. Patricius *proceeds, and goes about to prove that the water alſo is not round or ſphæricall. And he borroweth his argument from the obſervations of thoſe that conveigh or levell waters, who finde by their Dioptricall Inſtruments; that waters have all an equall and plaine ſuperficies, except they be troubled by the violence of windes. On the contrary ſide,* Eratoſthenes *in* Strabo *affirmes, that the ſuperficies of the Sea is in ſome places higher, then it is in other. And he alſo produceth, as aſſertors of his ignorance, thoſe Water-levellers, who being employed by* Demetrius *about the cutting away of the* Iſthmus, *or necke of land betwixt* Peloponeſus *and* Greece; *returned him anſwere, that they found by their Inſtruments, that that part of the Sea which was on* Coſinth's *ſide, was higher then it was at* Cenchræe. *The like is alſo ſtoried of* Seſoſtris, *one of the Kings of* Ægypt, *who going about to make a paſſage out of the* Mediterranean *into the* Arabian *gulfe, is ſaid to have deſiſted from his purpoſe, becauſe he found that the ſuperficies of the* Arabian *gulfe was higher then was the* Mediterranean: *as it is reported by* Ariſtotle *in the end of his firſt booke of* Meteors. *The like is alſo ſaid in the ſame place by the ſame Authour to have happened afterward to* Darius. *Now whether the* Architects *or* Water-levellers, *imployed by* Demetrius, Soſoſtris, *and* Darius, *deſerve more credit,*

dit, then thoſe whom Patricius nameth, I ſhall not much trouble my ſelfe to examine. Yet Strabo inveigheth againſt Eratoſthenes for attributing any ſuch eminencies and depreſſions to the ſuperficies of the Sea. And Archimedes his doctrine is, that every humid body, ſtanding ſtill and without diſturbance, hath a Spharicall ſuperficies, whoſe center is the ſame with that of the earth. So that wee have juſt cauſe to reject the opinions, both of thoſe that contend that the ſuperficies of the Sea is plaine; as alſo of thoſe that will have it to be in ſome places higher then in other. Although wee cannot in reaſon but confeſſe, that ſo ſmall a portion of the whole Terreſtriall Globe, as may be comprehended within the reach of our ſight, cannot be diſtinguiſhed by the helpe of any Inſtruments from a plaine ſuperficies. So that we may conclude Patricius his argument, which he alleadgeth from the experience of Water-conveighers, to be of no weight at all.

But hee goes on, and labours to prove his aſſertion from the elevation and depreſſion, riſing and ſetting of the Poles and Starres, which are obſerved daily by thoſe that traverſe the Seas: all which, he ſaith, may come to paſſe, although the ſurface of the water were plaine. For if any Starre be obſerved, that is in the verticall point of any place; which way ſoever you travell from that place, the ſame Starre will ſeeme to bee depreſſed, and abate ſomething of its elevation, though it were on a plaine ſuperficies. But there is ſomething more in it then Patricius takes notice of. For if wee goe an equall

meaſure

measure of miles either toward the North, or toward the South; the elevation or depression of the Starre will alwayes bee found to bee equall: which that it can possibly bee so in a plaine superficies, is more then hee will ever be able to demonstrate. If wee take any Starre situate neare the Æquator, the same when you have removed thence 60. English miles, will be elevated about a degree higher above the Horizon, whether the Starre be directly over your head, or whether you depart thence, that so it may bee depressed from your Zenith, for 30. or 50. or any other number of degrees. Which that it cannot thus bee on a plaine superficies, may bee demonstrated out of the principles of Geometry. But yet me thinkes, this one thing might have perswaded Patricius (*being so well versed in the Histories of the* Spanish *Navigations, as his writings sufficiently testifie*) *that the superficies of the Sea is not plaine; because that the Ship called the* Victory, *wherein* Ferdinand Magellane *losing from* Spaine, *and directing his course toward the Southwest parts, passed through the Straits, called since by his name, and so touching upon the* Cape of good hope, *having encompassed the whole world about, returned againe into* Spaine. *And here I shall not need to mention the famous voyages of our owne Countriemen,* Sir Francis Drake, *and* Master Thomas Candish, *not so well knowne perhaps abroad; which yet convince* Patricius *of the same errour. And thus have wee lightly touched the chiefe foundati-*

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ons that his cauſe is built upon: but as for thoſe ill underſtood experiments, which he brings for the confirmation of the ſame. I ſhall let them paſſe, for that they ſeeme rather to ſubvert his opinion, then confirme it.

Thus having proved the Globe of the Earth to be of a Spharicall figure, ſeeing that the Eminency of the higheſt Hils hath ſcarcely the ſame proportion to the Semidiameter of the Earth, that there is betwixt 1. and 1000. which how ſmall it is, any one may eaſily perceive: I hold it very ſuperfluous to goe about to prove, that a Globe is of a figure moſt proper and apt to expreſſe and repreſent the faſhion of the Heavens and Earth, as being moſt agreeable to Nature, eaſieſt to bee underſtood, and alſo very beautifull to behold.

Now in materiall Globes, beſides the true and exact deſcription of places, which indeed is the chiefeſt matter to bee conſidered; there are two things eſpecially required. The firſt whereof is the magnitude and capacity of them; that ſo there may bee convenient ſpace for the deſcription of each particular place or region: the ſecond is the lightneſſe of them; that ſo their weight be not cumberſome. Strabo in his eleventh booke, would have a Globe to have tenne foot in Diameter, that ſo it might in ſome reaſonable manner admit the deſcription of particular places. But this bulke is too vaſt to bee conveniently dealt withall. And in this regard, I thinke that thoſe Globes, of which I intend to ſpeake in this enſuing diſcourſe, may juſtly

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bee preferred before all other that have beene ſet forth before them; as being more capacious then any other: for they are in Diameter two foot, and two inches: whereas Mercator's Globes, (which are bigger then any other ever ſet forth before him,) are ſcarcely ſixteene inches Diameter. The proportion therefore of the ſuperficies of theſe Globes to Mercator's, will bee as 1. to $2\frac{3}{8}$. and ſomewhat more. Every Countrey therefore in theſe Globes will bee above twiſe as large as it is in Mercator's: ſo that each particular place may the more eaſily bee deſcribed. And this I would have to bee underſtood of thoſe great Globes made by William Saunderſon of London; concerning the uſe of which eſpecially we have written this diſcourſe. For he hath ſet forth other ſmaller Globes alſo, which as they are of a leſſer bulke and magnitude, ſo are they of a cheaper price: that ſo the meaner Students might herein alſo be provided for. Now concerning the Geographicall part of them, ſeeing it is taken out of the neweſt Charts and deſcriptions; I am bold to think them more perfect then any other: how ever they want not their errors. And I thinke it may bee the Authors glory to have performed thus much in the edition of theſe Globes. One thing by the way you are to take notice of: which is, that the deſcriptions of particular places are to bee ſought for elſewhere; for this is not to bee expected in a Globe. And for theſe deſcriptions of particular Countries, you may have recourſe to the Geographicall tables of Gerardus Mercator,

whoſe

whose diligence and industry in this regard seemes to exceed all other before him. To him, therefore we referre you.

PONT. STRABO in the place above cited by the Author, speakes of a *Globe* of that bignesse, not such an one as himselfe had made, but such an one as he could wish were made; that so it might be every way absolute. And indeed within this age of ours, the magnificent and Illustrious *Tycho Brahe*, who is now deservedly celebrated with the title of a *Second Atlas*, hath made a very faire Cœlestiall *Globe* composed all of wood within, and covered over with plates of Copper artificially wrought, containing sixe foot in Diameter, besides the Meridian, and Horizon, and other appendances which may be guessed at by the rest. The like whereof, so coldly and elaborately framed and every way exactly answering it selfe, I thinke was never made by any. And indeed it is a vast and magnificient peece of worke: insomuch that many strangers came out of diverse parts into *Denmarke*, while it was there, only to see this *Globe*. But *Tycho* afterward betaking himselfe to the Emperours Court, caried this *Globe* with some certaine other Mathematicall instruments with him. All which after the death of *Tycho*, were bought for a great sum of money by the Emperour, and are now preserved at *Prage* in the Imperiall Castle, and shewed among other rarities there. About the Horizon are read these words, written in letters of gold.

Anno a Chriſto nato CIↃ. IↃ. XCIV. *Regnante in Dania Friderico ſecundo, hunc Cœleſti machinæ conformem Globum, in quo affixa octavæ Sphæræ ſidera calitùs organis deprehenſa, ſuis quæque locis ad amuſſim repræſentare, Errantiumque ſtellarum per hæc apparentias perpervestigare decrevit, cœlo terrigenis, qui rationem eam capiunt, Mechanico opere patefacto,* TYCHO BRAHE, *O. F. Sibi & Poſteris F. F.*

Which *Globe*, by reaſon of its extraordinary magnitude, hath this prærogative above all other, that all things may be done upon it moſt exactly, and in the very minute, eſpecially as farre as concernes the doctrine of the *Firſt moveable*, together with the obſervations of the Starres, and their aſpects in reſpect of the Eclipticke and Æquator: all which may bee done mechanically, without any tedious computations.

The great *Duke* of *Tuſcany* hath alſo two very faire *Globes*, as large as this, but made after the ordinary manner; the one a Terreſtriall *Globe*: but the other an *Armillary Sphære*, conſiſting of Circles and Orbes only.

Now concerning thoſe Globes *of* Mercator, *ſpoken of by our Author; the ſame have beene ſince accurately corrected, according to* Tycho's *obſervations, and ſet forth both in a greater, and leſſer forme by* I. Hondius, *and are ſtill made and ſold by his Sonne.*

And becauſe that in this enſuing diſcourſe of Globes, *there is often mention made of a* Point, Line,

Line, Superficies, Angle, Rhombus, Axis, *and other the like Geometricall tearmes: I have thought good to ſet downe the ſeverall definitions of the ſame.*

A Point, *is that which hath no parts: or a thing ſuppoſed to be Indiviſible, or that cannot be divided into parts.*

A Line, *is a ſuppoſed length without breath: whoſe extreames or bounds are two Points.*

A Right Line, *is the ſhorteſt of all Lines drawne from any two the ſame Points.*

Parallels, *are Lines equidiſtant from each other: which though they ſhould be protended infinitely, would never meet in one point, but keepe ſtill the ſame diſtance mutually.*

A Perpendicular, *is a Right line, falling directly on a Right line, and making on each ſide that point where they touch, two equall Right Angles.*

A Superficies, *is a Longitude, having onely Latitude: whoſe tearmes and limits are two Lines.*

A Figure, *is that which is comprehended within one, or many bounds: under one bound is comprehended a Circle: and all other Figures under many.*

A Tearme *or Limit, is that which is the end of any thing.*

A Circle, *is a Plaine Figure, comprehended under one round line: in the midſt whereof there is a Point, from whence all Lines drawne to the Circumference are equall.*

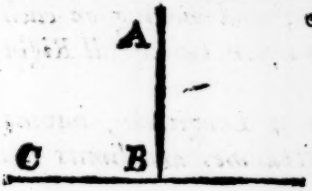
The Center *of a Circle, is that Point in the midſt, from which all equall lines are drawne to the Circumference.*

The Diameter *of a Circle, is a Right line paſſing through the Center, terminated at each end with the Circumference, and dividing the Circle into two equall Parts.*

A Semicircle *is the halfe of a Circle, contained within the Diameter and halfe the Circumference.*

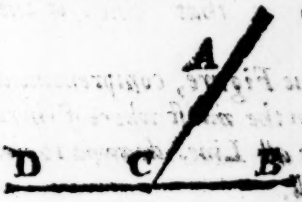
An Arch, *is a Portion of a Circle, compreprehended within a Right line, and any part of the Circumference, and is alwayes either greater or leſſe then a Semicircle.*

An Angle *is, when two lines are extended upon the ſame ſuperſicies, ſo that they touch one another in a Point, but not directly.*



A Right Angle, *is that which is produced of a Right line falling upon a Right line, and making two equall Angles, on each ſide the point where they touch each other: As the lines A, B, C.*

An Obtuſe Angle, *is that which is Greater then a Right Angle: as the Angle A, C, D.*



An Acute Angle, *is that which is leſſe then a Right: as the Angle A, C, B.*

A Solid Angle, *is that which is comprehended under*

under more then two plaine Angles, which are not in the ſame ſuperficies, and meeting all in one point: as are the Angles of a Cube, or Die.

Rhombus, *is a Figure Quadrangular, having equall ſides, but not equall Angles.*

Rhomboides, *is a Figure having neither equall ſides, nor equall Angles: yet the Oppoſite ſides and Angles are equall.*

A ſolid Body, *is that which hath length, breadth, and thickneſſe; as a Cube or Die: and the Limits or extreames of it are ſuperficies.*

The Axis *is that Diameter, about which the Sphære or Globe is turned.*

The Poles *of a Sphære, are the Extreames, or ends of the Diameter, and are terminated in the ſuperficies of the Sphære.*

A Sphære *is defined by* Euclide *to be, when the Diameter of a ſemicircle remaining fixed, the Semicircle is turned about, till it returne againe to the place, whence it began to move at firſt.*

THE

The first Part,

Of those things which are common both to the Cœlestiall, and Terrestiall GLOBE.

CHAP. I.

What a Globe is, with the parts thereof: and of the Cirtles of the Globe.



A Globe, in relation to our present purpose, we define to be an Analogicall representation either of the Heavens, or the Earth. And we call it Analogicall, not only in regard of it's forme, expressing the Sphæricall figure, as well of the Heavens, as also of the Terrestriall Globe, consisting of the Earth it selfe, together with the interflowing Seas: but rather because that it representeth unto us in a just proportion and distance, each particular constellation in the Heavens, and every severall region and tract of ground in the Earth, together with certaine circles, both greater and lesser, invented by Artificers for the more ready computation of the same. The greater Circles we call those, which

divide the whole superficies of the Globe into two equall parts, or halfes: and those the lesser, which divide the same into two unequall parts.

PONT. *A Globe is also called a Sphære: only with this distinction, that a Sphære is properly such an one, as consists only of circles or little hoopes of brasse, or the like matter, and is not a solid body, as is a Globe: the Latines call it Armillaris. Now these Circles whereof it is made, although we are not to conceive that there are any such reall ones in the Heavens; yet they have beene invented by Artificers, to the end that by meanes of the same, the doctrine of the true motions of the Cœlestiall bodies might the more easily bee apprehended. And what is said of the* Æquator, Zodiaque, Axes, *and the other Circles, is also to bee understood of the other Orbes themselves, and their Hypotheses. For as concerning the objections made long since by* Rhœticus, *and lately by* Peter Ramus lib. 2. Schol. Math. *touching the facility the ancient* Ægyptians *had in searching out the courses of the Starres: I thinke it not amisse to let you see what the Noble* Tycho's *opinion is herein, and what answer hee once upon occasion gave* Ramus *himselfe, proposing the same unto him: as we find it related by himselfe in his booke of Astronomicall Epistles pag.* 60. *And thus it is.*

Quod celeberrimus ille nostri ævi Philosophus P. Ramus, &c. *Whereas that famous Philosopher of our times,* Peter Ramus, *was of opinion, that the Science of Astronomy might be framed by some certaine* Logicall *wayes of computation,*

putation, with Hypotheſes: *this is nothing elſe but a meere ground-leſſe conjecture. Which conceit of his, he propoſed indeed to me about ſixteene yeares ſince, when as wee were together at* Auſpurge: *wiſhing mee withall, that when as I had once reduced the courſe of the Starres into ſome exact order, by the* Hypotheſes *now in uſe; I would then try what might be done without them. And that this might poſſibly be effected, he brought this for his reaſon, becauſe that he had read, that the* Ægyptians *had anciently a moſt eaſie and facile way and method in their Aſtronomy. And therefore, ſeeing that this way of computation by* Hypotheſes *is very intricate and difficult; it muſt needs follow, that they had a more plaine and compendious way to the knowledge of the courſe of the Starres, and that without them. But I oppoſed him herein, ſhewing withall, that it was altogether impoſſible that the Cœleſtiall Apparences ſhould bee reduced into any certaine order or ſcience, ſo as to bee underſtood, without the helpe of* Hypotheſes. *And that this facility of the* Ægyptians *was only in the Æquatories of the Planets, whereby they freed themſelves from all tedious ſupputation; whereas the eaſie and facile uſe of the* Ephemerides *was not as yet brought to light. But for as much as he (though otherwiſe a man of an excellent apprehenſion and wit, and a great lover of the truth) ſeemed not to bee ſo throughly acquainted with the hidden ſecrets of this intricate Science, and conſidered not that the courſe of the Heavenly bodies did not keepe a conſtant period at any ſet time: I neither could, nor*

indeed desired to get any thing of him, in this matter. He hath many Sectaries at this day, who have a strong faith of the possibility of this thing: but such they are, that neither understand the matter themselves, nor will ever be able to bring it to any effect. For seeing that all things consist in number, weight, and measure: without these there is not any thing in this visible world that can bee explained or understood. Now the office of these Hypotheses *is, only to shew the measure of the apparent motion of the Heavenly bodies, by circles and other figures: which are againe resolved into numbers by Arithmeticke. Without which whosoever shall thinke to attaine to the knowledge of the motion of the Starres: hee may bee said to invoke Fortune, (as the Proverbe is:) and dreames of some strang incorporeall, and more than Seraphicall way, above the reach of humane capacity.*

Besides the body of the Globe it selfe, and those things which we have said to be thereon inscribed, there is also annexed a certaine frame, with necessary instruments thereto belonging: which we shall declare in order.

The fabricke of this frame is thus. First of all there is a Base, or foot to rest upon: on which there are raised perpendicularly sixe [c] Pillars [b] *or* [a] *Columnes*, of equall length and distance; upon the top of which there is fastned to a levell, and parallel to the Base, a round plate or circle of wood, of a sufficient breadth and thickneſſe, which they call the *Horizon*: because that the uppermost superficies thereof performeth the office of the true *Horizon*. For

The Horizon.

it is ſo placed, that it divideth the whole Globe into two equall parts. Whereof that which is uppermoſt, repreſenteth unto us the viſible Hemiſphære, and the other, that which is hid from us. So likewiſe that Circle which divides that part of the world which wee ſee, from that other which we ſee not, is called the *Horizon*. And that point which is directly over our heads in our *Hemiſphære*, and is on every ſide equidiſtant from the *Horizon*, is commonly called *Zenith*: but the *Arabians* name it *Semith*. But yet the former corrupted name hath prevailed, ſo that it is alwayes uſed among Writers generally. And that point which is oppoſite to it in the lower Hemiſphære, the *Arabians* call *Nathir*; but it is commonly written *Nadir*. Theſe two points are called alſo the *Poles* of the *Horizon*.

Furthermore, upon the ſuperficies of the *Horizon* in a materiall Globe there are deſcribed, firſt, the twelve Signes of the *Zodiaque*: and each of theſe is againe divided into thirty leſſer portions; ſo that the whole *Horizon* is divided into 360. parts, which they alſo call degrees. And if every degree be divided into ſixtie parts alſo, each of them is then called a Scruple or Minute; and ſo by the like ſubdiviſion of Minutes into ſixtie parts, will ariſe Seconds, and of theſe Thirds, and likewiſe Fourths, and Fifths, *&c.* by the like partition ſtill of each into ſixtie parts.

POINT. *In the midſt among theſe Signes are there deſcribed certaine Charatters, to denote the*

particular Planet, to whose dominion each Signe doth appertaine. Next to this there is another Section, wherein are set downe the severall dayes of every Weeke: after that followeth the number of the dayes of every Moneth throughout the whole yeare. Besides this number of the dayes, each of them hath in their severall orders some one of these three Letters affixed, K. N. I. *signifying the* Kalends, Nones, *and* Ides, *which tearmes the Ancient* Romans *used in their accompts, to signifie the dayes of every Moneth. For they did not reckon as we doe now, from the first day of every Moneth to the* 30. *or* 31. *of the same; but their account was according to the* Kalends, Nones, *and* Ides. *So that the first of each moneth was the* Kalends; *and the rest of the dayes of the same moneth were not reckoned forward, but after a retrograde manner. As for example: The last day of* December, *which with us is the* 31. *they called the second of the* Kalends *of* Ianuary, *and the* 30. *of the same moneth, the third of the* Kalends *of* Ianuary: *thus reckoning backeward till they came to the* Ides, *which was the fourteenth of* December, *and the nineteenth of the* Kalends *of* Ianuary. *The like order they observed in the* Ides *and* Nones *also. Now what moneths have more or fewer* Kalends *or* Nones *may be found upon the* Horizon, *as we have said: and as may be gathered also out of these old verses.*

Majus *sex Nonas,* October, Iulius, *&* Mars:
Quatuor at reliqui. Tenet Idus quilibet octo.
Inde dies reliquos dic omnes esse Calendas.

There is also described upon the *Horizon* the *Roman*

Romane Calendar, and that three ſeverall wayes: to wit, the ancient way, which is ſtill in uſe with us here in *England*; and the new way, appointed by Pope *Gregory* 13. wherein the Equinoxes and Solſtices were reſtored to the ſame places, wherein they were at the time of the celebration of the Councell of *Nice*: and in the third, the ſaid Equinoctiall and Solſticiall points are reſtored to the places that they were in at the time of our Saviour *Chriſts* nativity. The moneths in the Calendar are divided into dayes and weekes: to which are annexed, as their peculiar characters, the ſeven firſt letters of the Latine Alphabet. Which manner of deſigning the dayes of the moneth, was firſt brought in by *Dionyſius Exiguus*, a *Romane* Abbot, after the Councell of *Nice*.

The innermoſt border of the Horizon is divided into 32. parts, according to the number of the windes, which are obſerved by our moderne Sea-faring men in their Navigations; by which alſo they are wont to deſigne forth the quarters of the Heavens, and the coaſts of Countries. For the Ancients obſerved but foure winds onely: to which were after added foure more: but after ages, not content with this number, increaſed it to twelve, and at length they brought it to twenty foure, as *Vitruvius* notes. And now theſe later times have made them up thirty two, the names whereof, both in *Engliſh* and Latine are ſet downe in the Horizon of Materiall Globes.

PONT. *The true Horizon is either Rationall or Sensible. The Rationall or Intelligible Horizon divideth the Sphære into two equall parts exactly; and these are called the upper and the lower Hemisphæres. The sensible or apparent Horizon, is so called because it onely seemes to divide the Heavens into two equall parts or Hemisphæres: whereas indeed it doth not divide it so exactly, but onely seemeth so to doe. The Rationall Horizon, is also called the Artificiall, because that it was brought in for the use of Astronomy.*

The use of the Horizon is manifold. First, it divides the Heavens into two Hemisphæres. Secondly, it sheweth what Starres never set, and what never rise from under the earth; and so likewise what Starres doe both rise and set. Thirdly, it shewes the cause of the equality and inequality of the artificiall dayes and nights. Fourthly, it conduceth to the finding out of the latitude of any place. Fiftly, it is the cause of the Rectitude and obliquity of the Sphære; whereof we have occasion to speake more largely hereafter.

There is also let into this Horizon, two notches opposite one to the other, a circle of brasse, making right angles with the said Horizon, and placed so that it may be moved at pleasure up and downe, by those notches, as neede shall require. This circle is called the *Meridian*, because that one side of it, which is in like manner divided into 360. degrees, supplyeth the office of the true *Meridian*. Now the *Meridian* is one of the greater circles, passing through the Poles of the world, and also

The Meridian.

of

of the Horizon ; to which when the Sunne in his daily revolution is arrived in the upper Hemisphære, it is midday ; and when it toucheth the same in the lower Hemisphære, it is midnight, at that place whose *Meridian* it is.

These two circles, the *Horizon* and *Meridian*, are various and mutable in the Heavens and Earth, according as the place is changed. But in the materiall Globe they are made fixed and constant : and the Earth is made moveable : that so the *Meridian* may be applied to the verticall poynt of any place.

PONT. *The uses of the* Meridian *are these especially.* First, *It determineth the poynt of midday, and midnight : whence the Astronomers begin the day alwayes from this circle.* Secondly, *In the* Meridian *is observed the* Zenith *or verticall poynt of places, whence afterward the distances of Starres and Parallel circles are gathered.* Thirdly, *The Longitude and Latitude of places are taken from hence.* Fourthly, *It shewes the greatest elevation of the Sunne, and other Starres : which elevation is called their* Meridian *Altitude.* Fifthly, *By the* Meridionall *elevation of the Sunne, when he is in the Æquinoctiall point, may bee found out the elevation of the Pole, and habitude or position of the Sphære. For a quarter of a circle being 90. degrees, if then we substract the* Meridionall *Altitude of the Sunne in the Æquinoctiall from 90. degrees, the remainder sheweth the elevation of the Pole. As for example, The elevation of the Sunne at noone when it is in*

the

the Æquinoxe, is about 38. *degrees With us here at* London : *Which being deducted out of* 90. *there remaines* 52. *Which is their elevation of the Pole With us. So at* Rome *the Æquinoctiall altitude of the Sunne is about* 48. *degrees ; Which being ſubſtracted from* 90. *degrees, Which is a Quadrant, there remaines* 42. *for their elevation of the Pole.*

The Poles and Axis.

In two oppoſite poynts, of this *Meridian*, are faſtened the two ends of an iron pinne, paſſing thorogh the body of the *Globe* and its Center. One of which ends is called the *Arcticke*, or North Pole of the world ; and the other the *Antarcticke*, or South Pole : and the pinne it ſelfe is called the *Axis*. For the *Axis* of the world is the *Diameter* about which it is turned. And the extreame ends of the *Axis*, are called the *Poles*.

The Houre-circle.

To either of theſe *Poles*, when need ſhall require, there is a certaine braſſe circle or ring, of a reaſonable ſtrong making, to be faſtened, which circle is divided into 24. equall parts, according to the number of the houres of the day and night : and it is therefore called the *Houre-circle*. And this circle is to be applied to either of the Poles in ſuch ſort, as that the Section where 12. is deſcribed, may preciſely agree with the points of mid-day and mid-night in the ſuperficies of the true Meridian.

There is alſo another little pinne or ſtile to be faſtened to the end of the Axis, in the very center of the *Houre-circle* : and this pinne is called in Latin, *Index Horarius*; and is ſo made, as that it turnes about and pointeth to every

of

of the 24. ſections in the *Houre-circle*, according as the Globe it ſelfe is moved about: ſo that you may place the point of it to what houre you pleaſe.

POINT. *The uſe of this* Houre-circle *and* Index *is to denote the houres of the riſeing and ſetting of the Sunne and other Starres: which muſt be practiſed after this manner. Firſt, you muſt ſet the Globe to your elevation or Pole, and then apply the degree of the ſigne, in which the Sunne at that time is, to the Meridian, and the* Index *to that twelfth houre which is uppermoſt. And ſo having thus done, you muſt turne the Globe about, till the degree wherein the Sunne is, come to the Eaſterne ſide of the Horizon; which done, the* Index *will point out the houre of his riſeing: and if you turne it about to the Weſt ſide, you ſhall in like manner have the houre of his ſetting.*

There is alſo belonging to the Meridian a Quadrant *of* Altitude, *being made of a long thin plate of ſteele or braſſe, and faſhioned crooked, ſo that it may be applied to the convexe Superficies of the Globe, and having the fourth part of the circle in length. And this* Quadrant *is made in ſuch ſort, as that it may be faſtened on the* Meridian, *and ſo be applyed to the* Zenith *of any place whatſoever, being divided from one end to the other into 90. equall parts or degrees.* The Quadrant of Altitude.

There is beſides at the foote of the Globe, a Mariners compaſſe placed: which ſerves to ſhew, how to place the Globe rightly, according to the foure winds or quarters of the world.

CHAP.

CHAP. II.

Of the Circles which are deſcribed upon the Superficies of the Globe.

AND now in the next place we will ſhew what Circles are deſcribed upon the Globe it ſelfe. And firſt of all, there is drawne a circle in an equall diſtance from both the Poles, that is 90. degrees, which is called the *Æquinoctiall*, or *Æquator*; becauſe that when the Sunne is in this Circle, dayes and nights are of equall length in all places. By the revolution of this Circle is defined a Naturall day, which the *Greekes* call νυχθήμερον For a day is twofold; *Naturall* and *Artificiall*. A *Naturall* day is defined to be the ſpace of time, wherein the whole *Æquator* makes a full revolution; and this is done in 24. houres. An *Artificiall* day is the ſpace, wherein the Sunne is paſſing thorough our upper Hemiſphære: to which is oppoſed the *Artificiall* night, while the Sunne is carried about in the lower Hemiſphære. So that an Artificiall day and night are comprehended within a Naturall day.

The Æquator.

A day Naturall and Artificiall.

The Parts of a day are called houres; which are either *Equall* or *Vnequall*. An *Equall* houre is the 24. part of a *Naturall* day, in which ſpace, 15. degrees of the *Æquator* doe alwayes riſe, and as many are depreſſed on the oppoſite part. An *Vnequall* houre is the 12. part of an

Houres equall and unequall.

an Artificiall day, betwixt the time of the Suns riſing and ſetting againe. Theſe houres are againe divided into Minutes. Now a Minute is the 60. part of an houre: in which ſpace of time, a quarter of a degree in the Æquator, that is, 15. minutes doe riſe, and as many ſet.

PONT. *The uſe of the* Æquator *conſiſts chiefely in theſe things. Firſt, it ſheweth the time of the* Æquinoxes, *which are alwayes when the Sunne falls upon the* Æquinoctiall *circle. And this is, when as the Sunne enters into the firſt degree of* Aries *and* Libra: *according to that of* Manilius.

Libra Ariéſq; parem reddunt noctemq; diemq;

In Engliſh thus.

The Sunne in Libra' *and* Aries *plac'd, each yeare: The day and night are equall every where.*

Secondly, the Æquator divides the Heavens into two equall parts, or Hemiſphæres, whereof one is called the Septentrionall or Northerne Hemiſphære: the other, the Meridionall or Southerne. Thirdly, it ſheweth the aſcenſion and deſcenſion of the parts of the Zodiacke: whence the length of the Artificiall day and night, for any poſition of Sphære, may be knowne. Fourthly, it ſheweth what Starres, and parts of the Eclipticke have any Declination.

The *Æquator* is croſſed or cut in two oppoſite points, by an oblique Circle, which is called the *Zodiacke*. The obliquity of this Circle is ſaid to have beene firſt obſerved by *Anaximander Mileſius*, in the 58. *Olympiad.* as *Pliny* writeth in his *lib.* 2. *Cap.* 8. who alſo in the ſame

The Zodiacke.

ſame place affirmes, that it was firſt divided into 12. parts, which they call *Signes*, by *Cleoſtratus Tenedius*, in like manner as we ſee it at this day. Each of theſe Signes is againe ſubdivided into 30. parts: ſo that the whole *Zodiacke* is divided in all into 360. parts, like as the other circles are. The firſt twelfth part whereof, beginning at the Vernall Interſection, where the *Æquator* and *Zodiacke* croſſe each other, is aſſigned to *Aries*, the ſecond to *Taurus*, &c. reckoning from Weſt to Eaſt. But here a young beginner in Aſtronomy may juſtly doubt, what is the reaſon, that the firſt 30. degrees, or 12. part of the *Zodiacke* is attributed to *Aries*, whereas the firſt Starre of *Aries* falls ſhort of the Interſection of the Æquinoctiall and Zodiacke no leſſe then 27. degrees. The reaſon of this is, becauſe that in the time of the Ancient *Greekes*, who firſt of all obſerved the places and ſituation of the fixed Starres, and expreſſed the ſame by Aſteriſmes and Conſtellations, the firſt Starre of *Aries* was then a very ſmall ſpace diſtant from the very Interſection. For in *Thales Mileſius* his time, it was two degrees before the Interſection: in the time of *Meton* the *Athenian* it was in the very Interſection: in *Timocharis* his time it came two degrees after the Interſection. And ſo by reaſon of it's vicinity, the Ancients aſſigned the firſt part of the Zodiacke to *Aries*, the ſecond to *Taurus*, and ſo the reſt in their order.: as it is obſerved by ſucceeding ages, even to this very day.

PONT.

PONT. Thales Milesius *was the first that calculated the time of the Æquinoxe, and Eclipses: and he flourished about the yeare of the Creation,* 3370. *which was about* 634. *yeares before* Christ. Meton *lived about* 431. *yeares before* Christ, *in the yeare of the Creation,* 3517. *He was the Sonne of* Pausanias, *and was a man of excellent knowledge in Astronomy. He also first invented the Moones Circle of* 19. *yeares: whose first new Moone fell upon the* 13. *day of the moneth* Scirophorion, *which is the same with our* 26. *of June, being on a Friday.* Vid. Diodorum Siculum. Censorinus *writes of him thus.* Præterea sunt &c. *There are (saith he) besides, many other great yeares: as the* Metonicall *yeare, which* Meton *the* Athenian *invented, and consisted of* 19. *common yeares, &c.* Timochares *was by nation an* Alexandrian, *and he lived* 300. *yeares before* Christ.

Vnder this circle, the Sunne and the rest of the Planets finish their severall courses and periods, in their severall manner and time. The Sunne keepes his course in the middest of the *Zodiaque*, and therewith describeth the *Eclipticke* circle. But the rest have all of them their latitude and deviations from the Suns course, or *Eclipticke*. By reason of which their digressions and extravagancies, the Ancients assigned the *Zodiaque* 12. degrees of latitude. But our moderne *Astronomers*, by reason of the Evagations of *Mars*, and *Venus*, have added on each side two degrees more: so that the whold latitude of the *Zodiaque* is confined within

within 16. degrees. But the *Eclipticke* onely is deſcribed on the *Globe*, and is divided, in like manner as the other circles, into 360. degrees.

PONT. *The Whole latitude of the Zodiaque is divided into two parts by the* Eclipticke, *Which is the circle or circumference under Which the Sun ſteeres his courſe continually. Whence it is called in Latine,* Via Solis, & Orbita Solis, *the Sunnes high Way. And in* Greeke, κύκλος διὰ μέσων τῶν ζῳδίων, *a Circle dividing the* Zodiacke *in the middeſt. And it is called the* Eclipticke, *becauſe the Eclipſes of the* Sunne *and* Moone *never happen, but When they are either in conjunction or oppoſition under this line, or very neare the ſame.*

The Sunne runneth thorough this Circle in his yearly motion, finiſhing every day in the yeare almoſt a degree by his Meane motion, that is 59. minutes, 8. ſeconds. And in this ſpace he twice croſſeth the *Æquator*; in two poynts equally diſtant from each other. So that when he paſſeth over the *Æquator* at the beginnings of *Aries* and *Libra*, the dayes and nights are then of equall lengeh. And ſo likewiſe when the Sunne is now at the fartheſt diſtance from the *Æquator*, and is gotten to the beginning of *Cancer*, or *Capricorne*, he then cauſeth the Winter and Summer Solſtices. I am not ignorant, that *Vitruvius*, *Pliny*, *Theon Alexandrinus*, *Cenſorinus*, and *Columella* are of another opinion; (but they are upon another ground,) when as they ſay, that the

Æquinoxes

Æquinoxes are, when as the Sunne paſſeth through the eighth degree of *Aries* and *Libra*, and then it was the midſt of Summer and winter, when the Sun entred into the ſame decree of *Cancer* and *Capricorne*. But all theſe Authors defined the Solſtices by the returning of the ſhadow of dials: which ſhadow cannot bee perceived to returne backe againe, as *Theon* ſaith, till the Sunne is entred into the eighth degree of *Libra* and *Aries*.

PONT. *The office and uſe of the* Zodiaque *is.* Firſt, *in that it is a rule or meaſure of the proper motion of the Planets.* Secondly, *By the helpe of the* Zodiaque *the true places of all the Starres are found: beſides it may bee knowne in what ſigne any fixed Starre or Planet may be ſaid to bee.* Thirdly, *It ſheweth the latitude of the Planets and fixed Starres.* Fourthly, *All Eclipſes happen when the Sunne and Moone are under the Ecliptique.* Fifthly, *The obliquity of the Ecliptique is the cauſe of the inequality of the artificiall dayes and nights.*

The ſpace wherein the Sunne is finiſhing his courſe through the *Zodiaque*, is defined to be a *Yeare*, which conſiſts of 365. dayes, and almoſt 6. houres. But they that thinke to find the exact meaſure of this period, will find themſelves fruſtrate: for it is finiſhed in an unequall time. It hath beene alwayes a controverſie very much agitated among the Ancient *Aſtronomers*, and not yet determined. *Philolaus* a *Pythagoræan* determines it to bee 365. dayes: but all the reſt have added ſomething

more to this number. *Harpalus* would have it to be 365. dayes and a halfe: *Democritus* 365. dayes and a quarter, adding beside the 164. part of a day. *Oenopides* would have it to be 365. dayes, and almost 9. houres. *Meton* the *Athenian* determineth it to be 365. dayes, 6. houres, and almost 19. minutes. After him *Calippus* reduced it to 365. dayes and 6. houres, which account of his was followed by *Aristarchus* of *Samos*, and *Archimedes* of *Syracusa*. And according to this determination of theirs, *Julius Cæsar* defined the measure of his Civile yeare, having first consulted (as the report goes) with one *Sosigines* a *Peripatetick*, and a great Mathematician. But all these, except *Philolaus*, (who came short of the just measure) assigned too much to the quantity of a yeare. For that it is somewhat lesse then 365. dayes, 6. houres, is a truth, confirmed by the most accurate observations of all times, and the skilfullest Artists in Astronomicall affaires. But how much this space exceedeth the just quantity of a yeare, is not so easie a matter to determine. *Hipparchus*, and after him *Ptolomy*, would have the 300. part of a day substracted from this measure: (for *Jacobus Christmannus* was mistaken, when he affirmed, that a Tropicall yeare, according to the opinions of *Hipparchus* and *Ptolomy*, did consist of 365. dayes, and the 300. part of a day) For they doe not say so, but that the just quantity of a yeare is 365. dayes, and 6. houres, abating the 300. part of a day: as may be plainely gathered out of

of *Ptolomy*, *Almageſt. lib*, 3. *cap.* 2. and as *Chriſtmannus* himſelfe hath elſewhere rightly obſerved. Now *Ptolomy* would have this to be the juſt quantity of a yeare perpetually and immutably: neither would he be perſwaded to the contrary, notwithſtanding the obſervations of *Hipparchus*, concerning the inequality of the Sunnes periodiacall revolution. But yet the obſervations of ſucceeding times, compared with thoſe of *Hipparchus* and *Ptolomy*, doe evince the contrary. The *Indians* and *Jewes* ſubſtract the 120. part of a day: *Albategnius* the 600. part: the *Perſians* the 115. part: according to whoſe account *Meſſahalah* and *Albumaſar* wrot their tables of the Meane motion of the Sunne. *Azaphius*, *Avarius* and *Arzachel* affirmed that the quantity aſſigned was too much, by the 136. part of a day. *Alphonſus* abateth the 122 part of a day: ſome others, the 128. and ſome the 130. part of a day. Thoſe that were lately imployed in the reſtitution of the Romane Calendar, would have almoſt the 133. part of a day to be ſubſtracted, which they conceived in 400. yeares, would come to three whole dayes. But *Copernicus* obſerved that this quantity fell ſhort, by the 115. part of a day. Moſt true therefore was that concluſion of *Cenſorinus*, that a yeare conſiſted of 365. dayes, and I know not what certaine portion, not yet diſcovered by Aſtrologers.

By theſe divers opinions here alleadged is manifeſtly diſcovered the error of *Dion*, which

is indeed a very ridiculous one. For he had a conceit that in the space of 1461. *Julian* yeares, there would be wanting a whole day for the just measure of a yeare; which he would have to be intercaled, and so the Civile *Julian* yeare would accurately agree with the revolution of the Sunne. And *Galen* also, the Prince of Physitians, was grossely deceived, when he thought that the yeare consisted of 365. dayes, 6. houres, and besides almost the 100. part of a day: so that at every hundred yeares end there must be a new intercalation of a whole day.

Now because the *Julian* yeare, (which was instituted by *Julius Cæsar*, and afterward received, and is still in use) was somewhat longer then it ought to have beene: hence it is that the Æquinoxes and Solstices have gotten before their ancient situation in the Calendar. For about 432. yeares before the incarnation of our Saviour *Christ*, the Vernall Æquinoxe was observed by *Meton* and *Euctemon*, to fall on the 8. of the Kalends of *Aprill*, which is the 25. of *March*, according to the computation of the *Julian* yeare. In the yeare 146. before *Christ* it appeares by the observations of *Hipparchus*, that it is to be placed on the 24. of the same moneth, that is the 9. of the Kalends of *Aprill*. So that from hence we may observe the error of *Sosigenes* (notwithstanding he was a great Mathematician) in that above 100. yeares after *Hipparchus*, in instituting the *Julian* Calendar, he assigned the Equinoxe

The mutation of the Æquinox, and Solstices.

quinoxe to be on the 25. of *March*, or the 8. of the Kalends of *Aprill*, which is the place it ought to have had almoſt 400. yeares before his time, This error of *Soſigenes* was derived to ſucceeding ages alſo: in ſo much that in *Gallens* time, which was almoſt 200. yeares after *Julius Cæſar*, the Æquinoxes were wont to be placed on the 24. day of *March* and *September*: as *Theodorus Gaza* reports. In the yeare of our Saviours Incarnation, it happened on the 10. of the Kalends of *Aprill*, or the 23. of *March*. And 140. yeares after, *Ptolomy* obſerved it to fall on the 11. of the Kalends. And in the time of the *Councell* of *Nice*, about the yeare of our Lord 328. it was found to be on the 21. of *March*, or the 12. of the Kalends of *Aprill*. In the yeare 831. *Thebit Ben Chorah* obſerved the Vernall Æquinoxe to fall on the 17. day of *March*: in *Alfraganus* his time it came to the 16. of *March*. *Arzachel* a *Spaniard* in the yeare 1090. obſerved to fall on the Ides of March, that is the 15. day. In the yeare 1316. it was obſerved to be on the 13. day of March. And in our times it is come to the 11. and 10. of the ſame moneth. So that in the ſpace of 1020. yeares, or thereabout, the Æquinoctiall points are gotten forward no leſſe then 14. dayes. The time of the Solſtice alſo about 388. yeares before *Chriſt*, was obſerved by *Meton* and *Euctemon* to fall upon the 28. day of Iune: as *Joſeph Scaliger*, and *Jacobus Chriſtmannus* haue obſerved. But the ſame in our time is found to be on the 12. of the ſame moneth.

The Eclipticke and Æquator are crossed by two great Circles also, which are called *Colures*; both which are drawne thorough the Poles of the world, and cut the Æquator at right Angles. The one of them passing thorough the points of both the Intersections; and is called the *Equinoctiall Colure*: The other passing through the points of the greatest distance of the Zodiacke from the Æquator is therefore called the *Solsticiall Colure*.

The Colures.

POINT. *The office of the Colures in generall is. First to shew the foure principall points of the Zodiacke, in which, by reason of the motion of the Sunne, there are caused the great changes of the Seasons of the yeare. Of which points, two are in the Æquator, at* Aries *and* Libra, *determining the place of the* Æquinoctiall Colure: *and the other two are in the* Tropickes *at* Cancer *and* Capricorne, *which constitute the Solsticiall Colure. Secondly, To distinguish the Æquator, Zodiacke, and the whole Sphære of the Heavens into foure equall parts. The use of which is principally seene in examining the ascensions of the Signes. These* Colures *differ from each other, in that the* Solsticiall Colure *passeth through the Poles of the world, and also of the Zodiacke: but the Æquinoctiall Colure passeth through the Poles of the world only.*

Now that both the Colures, as also the Æquinoctiall points have left the places, where they were anciently found to be in the Heavens, is a matter agreed upon by all those that have applyed themselves to the observations

tions of the Cœleſtiall motions: onely the doubt is, whether fixed Starres have gone forward unto the preceding Signes, as *Ptolomy* would have it: or elſe whether the *Æ*quinoctiall and Solſticiall points have gone backward to the ſubſequent Signes, according to the *Series* of the Zodiacke, as *Copernicus* opinion is.

PONT. *What the opinion of* Ioſeph Scaliger *was, concerning the proceſſion of the Æquinoctiall points, thus diverſly thought on by* Ptolomy *and* Copernicus, *you have expreſſed in an Epiſtle of his to* Iſaac Caſaubon, *there having beene not long before a diſputation holden concerning ſome certaine Mathematicall queſtion, at the entreaty of ſome of the chiefeſt of the States in the Low-Countries; among which number* Scaliger *was choſen alſo, as an Arbitrator: which Epiſtle of his, was afterward printed among ſome other of his Epiſtles at* Paris. *What the Illuſtrious* Tycho *alſo thought concerning this point, you have in his* Progymnaſmata Inſtaur. Aſtron. *p.* 255. *But I will firſt ſet downe* Scaliger's *opinion: and afterward adde* Tychoe's, *and ſome others alſo.* Scaliger ſpeaketh thus.

Alteræ literæ tuæ, &c. *I received (ſaith he) your ſecond letters the next day after your former. In which you make mention of one that undertakes to diſcourſe of the Magneticall direction of the Needle. Many indeed have endeavoured in this matter, and doe dayly endeavour, being thereto incouraged by by the rewards propoſed by the Illuſtrious States. To whoſe hands ſome have de-*

livered up their opinions in writing: and Arbitrators forthwith have beene called about it. Of which number it was my chance to be chosen for one: there being indeed amongst them many excellent, both Mathematicians and Mariners. But those that professed the Mathematickes, were altogether unexperienced in Nauticall affaires: and the Navigators were as ignorant of Astronomicall. Besides, those Authors of whom we were to passe our judgements, performed nothing worth so great expectation. Neither hath that Englishman, *who wrote a Booke three yeares since, of the* Magnet, *produced any thing answerable to the great opinion was raised of it. I my selfe have often proposed to these Mathematicians that professe in this place, a thing which it seemes can never sinke into their heads: in so much that they entertained it with scorne and laughter.* Hipparchus *was the first that brought in that merry conceit of the eight Spheres moveing toward the East: and so perswaded* Ptolomy, *that the fixed Starres in the eight Sphere moved all in the same order, situation, and distance from each other, toward the East. Which* Ptolomy *so confirmed, that it had beene a heinous matter for posterity to have doubted of the same. And first of all within the memory of our Fathers,* Nicolaus Copernicus, *that great restorer of Astronomy, perceived the weakenesse of this conceit of* Hipparchus: *and with all observed, that the eight Sphere did not move toward the East, but that the Æquinoctial points went forward into the precedent Signes: and this he calls* προήγησιν ἰσημερινῶν

But

But this observation of his, hee onely nakedly proposed, without any demonstration at all. But I have observed, that the Starres have not (as Hipparchus *and* Ptolomy *dreame) gone on to the subsequent parts: and that the* Cynosure, *or Polar Starre, was at the same distance from the Pole in* Eudoxus *his time, as it is at this day. For proofe of which assertion I have collected many instances: which being granted, the precession of the Æquinoctiall points must necessarily follow. For one of these two must needs be granted; to wit, either the motion of the eighth Sphare toward the East, or else the progresse of the Æquinoctiall points into the precedent Signes. Now that the first is not to be admitted appeares manifestly, because that the fixed Starres have not at all changed their situation in respect of the Pole, since* Eudoxus *his time. Therefore the other must needs be granted. The Æquinoctiall points therefore have gone forward to the antecedent Signes. Which proposition notwithstanding the great* Copernicus *had no way to demonstrate, but out of the* Phænomena; *by which that other motion might as well be defended, as this. Wee therefore now have this* προήγησις ἰσημερινῶν *But what is it? Even nothing else, but the motion of the Æquinoctiall points into the precedent Signes. Now if the Æquinoctiall points be moveable; and the Æquinoctiall Circle be described by these points; the Æquinoctiall Circle then must needs be moveable also: which is as true, as truth it selfe. And if the Æquinoctiall circle be moveable; his Poles must be moveable also: and*

so

so the Poles of the Æquinoctiall must be divers from the Poles of the world. For the Pole of the world is immoveable; but this moveable. Besides, all the Meridian circles doe passe through the Poles of the Æquinoctiall: and in the superficies of stone Dialls, the Meridian line, which is drawne for the placeing of the Sunne Diall, is understood to passe through the Poles of the Æquinoctiall; which is confest by all men, and is most true. But because the Poles of the Æquinoctiall are moveable, the Meridian lines, that passe through the same, must be moveable also. And therefore it necessarily followeth, that after some certaine number of yeares, there will be no further use of these Meridian lines in the designing of the houres in Dialls; but a new Meridian line must be taken, and the situation of the Diall altered, though not the Diall it selfe. We may therefore conclude, that the Sunne Dialls, after some certaine time, will prove false, unlesse the Meridian line be rectified. This is demonstrated out of the very principles of the Mathematickes. But besides this, we have some notable instances out of the Ancients, which doe manifestly evince, that after some terme of yeares, Sunne Dialls doe not agree to their first designations: all which I have diligently collected. These things thus demonstrated, I proposed them to these Mathematicians, that, because the whole businesse of the Magneticall Needle had dependance upon these Meridians, they would consider whether or no this doctrine, by me first proposed, might open the way to the matter in hand, &c.

Thus

Thus farre Scaliger. *Let us now heare* Tycho. Inæqualitatis, inquit, circa motum, &c. *That the reason (saith he) of the inaequality observed in the motion of the fixed Starres, or as* Copernicus *calls it, the Anticipation of the Æquinoxiall points (which is a very subtile and ingenuous speculation of his owne, that so he might reconcile and maintaine the inventions of all that went before him) that this conceit, I say, doth not* constare sibi, *these 70. yeares observations of the Starre called* Spica Virginis, *since his first observing the same, doe manifestly prove. For in this space of time, the reciprocation of the Æquinoctiall points, or promotion of the Starres, is swifter by much then he conceived it would have been. So that whereas now they ought to have finished but one degree in an hundred yeares space, or thereabout, they finish the same in 70. the quantity of the yeare being not so slow as he imagined it to be: as appeares plainely by that we have delivered in the former Chapter. For these two things doe mutually cohere together in* Copernicus, *that when the quantity of the yeare is greatest, the motion of the fixed Starres should then be slowest. But these things the accurate observations of these present yeares doe manifestly elude, for as much as they doe not answer his periodicall restitutions.*

Thus these two great lights of our times, Tycho, *and* Scaliger, *to whom we may adde the opinion of our Countryman* Dr. Gilbert, *who in his* 6th *booke* de Magnete, *will have the præcession of the Æquinoctiall poynts to depend upon the Magneticall*

Magneticall motion of the Poles of the Earth. And this is that English-man, *as farre as I can gather, whom* Scaliger *mentions in his fore-cited Epistle. Vnto whom I referre you for satisfaction in this point, in his* lib. 6. cap. 8.

The first Starre of *Aries*, which in the time of *Meton* the *Athenian*, was in the very Vernall Intersection, in the time of *Thales Milesius* was two degrees before the Intersection. The same in *Timochares* his time, was behind it two degrees, 24. minutes: in *Hipparchus* time, 4. degrees, 40. minutes: in *Albumasars* time, 17. degrees, 50. minutes: in *Albarenus* his time, 18. degrees, 10. minutes: in *Arzachels* time, 19. gr. 37. minutes: in *Alphonsus* his time, 23 degrees, 48. minutes: in *Copernicus* and *Rhœticus* his time 27. degrees, 21. minutes. Whence *Franciscus Baroccius* is convinced of manifest error, in that he affirmes that the first Starre of *Aries*, at the time of our Saviours Nativity, was in the very Vernall intersection: especially contending to prove it, as he doth, out of *Ptolomies* observations, out of which it plainely appeares, that it was behinde it no lesse then 5. degrees.

In like manner the places of the Solstices are also changed, as being alwayes equally distant from the Æquinoctiall points. This motion is finished upon the Poles of the Ecliptick, as is agreed upon both by *Hipparchus* and *Ptolomy*, and all the rest that have come after them. Which is the reason that the

the fixed Starres have alwayes kept the ſame latitude, though they have changed their declination. For confirmation whereof many teſtimonies may be brought out of *Ptolomy*, lib. 7. cap. 3 *Almag.* I will onely alleadge one more notable then the reſt, out of *Ptolomies* Geogr. lib. 1. cap. 7. The Starre which we call the *Polar Starre*, and is the laſt in the taile of the Beare, is certainely knowne in our time to be ſcarce three degrees diſtant from the Pole: which very Starre, in *Hipparchus* his time, was above 12. degrees diſtant from the Pole: as *Marinus* in *Ptolomy* affirmes. I will produce the whole paſſage, which is thus. *In the Torrid Zone,* (ſaith he) *the whole Zodiacke paſſeth over it, and therefore the* ſhadowes are caſt both wayes, and all Starres *there are ſeene to* riſe and ſet. Onely the little Beare begins to *appeare above the* Horizon in thoſe places, that are 500. furlongs *Northward from Ocele.* For the Parallel that paſſeth through *Ocele* is *diſtant from* the Æquator 11. gra. $\frac{2}{5}$. And *Hipparchus* affirmes, that the Starre *in the* end of the little Beares taile, which is the moſt Southward *of that Conſtellation, is diſtant* from the *Pole* 12. *gr.* $\frac{2}{5}$. This excellent teſtimony of his the Interpreters have in their tranſlating the place, moſt ſtrangely corrupted (as both *Johannes Wernerus*, and after him *P. Nonius* have obſerved) ſetting downe in ſtead of 500. *Quinque mille*, 5000. and for *Auſtraliſſimam*, the moſt Southerne, *Borealiſſimam*, the moſt Northerly:

ly: being led into this error perhaps, becauſe that this Starre is indeed in our time the moſt Northerne. But if theſe teſtimonies of *Marinus* and *Ptolomy* in this point be ſuſpected, *Strabo* in his *lib.* 2. *Geogr.* ſhall acquit them of this crime. And he writes thus. It is affirmed by *Hipparchus* (ſaith he) that thoſe that inhabit under the Parallel that runneth thorough the Countrey called *Cinnamomifera* (which is diſtant from *Meroë* Southward, 3000. furlongs. and from the Æquinoctiall, 8800.) are ſituated almoſt in the midſt, betwixt the Æquator and the Summer Tropicke, which paſſeth through *Syene* (which is diſtant from *Meroë* 5000. furlongs) And theſe that dwell here, are the firſt that have the Conſtellation of the little Beare incloſed within their Arcticke Circle, ſo that it never ſets with them: for the bright Starre, that is ſeene in the end of the taile (which is alſo the moſt Southward of all) is ſo placed in the very Circle it ſelfe, that it doth touch the Horizon. This is the teſtimony of *Strabo*, which is the very ſame that *Ptolomy* and *Marinus* affirme; ſaving that both in this place, and elſewhere, he alwayes aſſignes 700. furlongs in the Earth, to a degree in the Heavens, according to the doctrine of *Eratoſthenes*: whereas both *Marinus* and *Ptolomy* allow but 500. onely: of which wee ſhall ſpeake more hereafter.

Let us now come to the leſſer Circles which

which are deſcribed in the Globe. And theſe are all Parallels to the Æquator: as firſt of all the *Tropickes*, which are Circles drawne through the points of the greateſt declination of the Eclipticke, on each ſide of the Æquator. Of which, that which lookes toward the North Pole, is called the *Tropicke* of *Cancer*: and the other, bordering on the South, the *Tropicke* of *Capricorne*. For the Sunne in his yearely motion through the Eclipticke, arriveing at theſe points, as his utmoſt bounds, returneth againe toward the Æquator. This Retroceſſion is called by the *Greekes*, Τροπαί, and the Parallel Circles drawne through the ſame points, are likewiſe called *Tropickes*. *The Tropickes.*

PONT. *The uſe of theſe Tropickes is, Firſt, to ſhew when the Sunne in an oblique Sphære, is neereſt the verticall point of any place, and ſo likewiſe when he fartheſt off. Secondly, they ſhew, when the Sunne in his Diurnall motion maketh the longeſt or ſhorteſt dayes in the yeare. Thirdly, they are, as it were, the limits and bounds, wherein the Sunne finiſheth his yearely courſe. Fourthly, they diſtinguiſh the Torrid Zone in the Heavens, from the two temperate Zones.*

The diſtance of the Tropickes from the Æquator, is diverſly altered, as it may plainely appeare, by compareing the obſervations of later times, with theſe of the Ancients. For, not to ſpeake any thing of *Strabo*, *Proclus*, and *Leontius Mechanicus*, who

who all aſſigned the diſtance of either Tropicke from the Æquator to be 24. degrees (for theſe ſeeme to have handled the matter but careleſſely) we may obſerve the ſame from the more accurate obſervations of the greateſt Artiſts. For *Ptolomy* found the diſtance of either Tropicke to be 23. gr. 51. min. and ⅓, juſt as great, as *Eratoſthenes* and *Hipparchus* had found it before him: and therefore hee conceived it to be immutable. *Machometes Aratenſis* obſerved this diſtance to bee 23. degrees, 35. minutes, right as *Almamon* King of *Arabia* had done before him. *Arzahel* the *Spaniard* found it to be in his time, 23. degrees, 34. minutes. *Almehon* the Sonne of *Albumaſar*, 23. degrees, 33. minutes, and halfe a minute. *Prophatius* a *Jew*, 23. degrees, 32. minutes, *Purbachius* and *Regiomontanus*, 25. degrees, 28. minutes. *Johan. Wernerus*, 23. degrees, 28. minutes and an halfe: and *Copernicus* found it in his time to be juſt as much.

PONT. *This diſtance of the Tropickes from the Æquator, is cauſed by the Sunnes greateſt declination, as the Aſtronomers call it. Which greateſt declination of the Sunne hath beene at divers times found to be variable. For beginning as farre backward, as poſſibly we can, and ſo driveing it downe by the Olympiads, and the yeares of Chriſt, even to theſe preſent times, according to* Tychoes *calculation, we finde it to be thus, both in the degree and minute, as is here expreſſed in this enſuing Table.*

Aratus

	gr. m. ii.	
Aratus	24. 0. 0.	*Olympiad.*
Hipparchus	23. 51½.	124.
Eratosthenes		127.
Ptolomæus	23. 51. 20.	An. Christi 140.
Albategnius	23. 35. 0.	749.
Arzahel	23. 34. 0.	1070.
Almeon	23. 33. ½.	1140.
Prophatius Iudæus	23. 32. 0.	1300.
Purbachius	23. 29. 30.	1458.
Regiomontanus	23. 30. 0.	1490.
Copernicus	23. 38. 30.	1500.
Tycho Brahe	23. 31. ½.	1592.

To which wee may adde these words out of Tychoes. 1. *Booke, of the new Star which appeared* An. 1572. p. 101. *where he saith, that by certaine observation it hath beene found, that both the Suns greatest declination, as also the other Intermediate by the same reason are altered, as it testified by the whole current of the most skilfull Artists in a continuall succession of time: so that* Ptolomies *time, and some certaine yeares before him, it was found to be* 23. *gr.* 51. ½. *but it doth not appeare by any certaine testimony to have beene ever greater. Whence may be collected, that* Aratus, *whom we have set in the first place, who assignes* 24. *gr. speakes with the largest, and as it were, at randome, and (as our learned Authour hath also observed of* Strabo, Proclus, *and* Leontius Mechanicus) *not so accurately as he should have.*

There are also two other lesser circles described in an equall distance from the Poles, to that of the Tropickes from the Æquator:

The Arctique, and Antarctique circles.

which circles take their denomination from the Pole on which they border. So that one of them is called the *Arcticke* or North circle; and the opposite circle the *Antarcticke* or Southerne. In these circles the Poles of the Ecliptique are fixed, the Solsticiall Colure crossing them in the same place. *Strabo, Proclus, Cleomedes*, all Greeke Authors, and some of the Latines also, assigne no certaine distance to these circles from the Poles: but make them various and mutable according to the diversity of elevation of the Pole, or diverse position of the Sphære: so that one of them must be conceived to bee described round about that Pole which is elevated, and to touch the very Horizon, and is therefore the greatest of all the Parallels that are alwayes in sight: and the other must be imagined as drawne in an equall distance from the opposite Pole; and this is the greatest of those Parallels that are alwayes hidden.

PONT. *The Arctique and Antarctique circles doe shew,* 1. *The Poles of the Zodiaque, and their distance from the Poles of the world.* 2. *They doe distinguish the frigid* Zones *from the Temperate, and with the Tropiques and Æquator they helpe to divide the whole Heaven into five parts or regions which they call* Zones.

Beside these circles expressed in the *Globe*, there are also some certaine other circles in familiar use with the Practicall Astronomers, which they call *Verticall* circles. These are greater circles drawne from the *Verticall* point through

The Verticall circles.

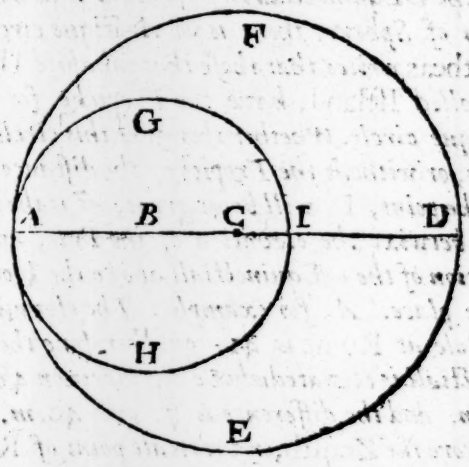
through the Horizon, in what number you pleaſe: and they are called by the *Arabians, Azimuth*, which appellation is alſo in common uſe among our ordinary Aſtronomers. The office of theſe circles is ſupplied by the helpe of a Quadrant of Altitude, which is a thin plate of braſſe, divided into 90. degrees. This Quadrant muſt bee applied to the vertex of any place, when you deſire to uſe it, ſo that the loweſt end of it, noted with the number of 90. may juſt touch the Horizon in every place. This Quadrant is made moveable, that ſo it may be faſtned to the verticall point of any place.

POINT. *Concerning the moveableneſſe or mutability of the Arctique and Antarctique Circles*, Ioſeph Scaliger *reports himſelfe to bee the firſt that obſerved it out of the Ancient Greeke Authors: as you may ſee in his Commentaries upon* Manilius, *reviſed, and publiſhed by himſelfe a little before his death. Neither doth he think that any ancient latine Author within 400. yeares after thoſe Greeke Writers, nor ſcarcely any before* Sacroboſco's *time, can be found to have determined them to bee immoveable. But becauſe there are many excellent things to be met withall in that paſſage of his, and that he ſets downe the ſame by way of demonſtration; I have thought it not impertinent, ſeeing our Author hath given a touch at it, to ſet downe* Scaliger's *opinion in his owne words: as you have them upon thoſe verſes of* Manilius, *lib.* 1. Aſtron.

Circulus ad Boreã fulgentem ſuſtinet Arcton,
Sexque fugit ſolidas a cœli vertice partes.

He proceeds after this manner. Describantur circuli Æquinoctiali paralleli XC &c. *Let there be described (saith he)* 90. *Parallel circles to the Æquinoctiall, and these will be the same that* Geminus *calles,* ἀειφανεῖς, *alwayes appearing. Now among all these, That which toucheth the Horizon in the point of intersection of the Horizon and Meridian, will be,* μέγιστος τῶν ἀφανιζομένων, *the greatest of those that alwayes appeare, and so consequently, the* Arctique *Circle of that place. Now because the Horizons are mutable, the Arctique Circles must also be moveable. So in the Climate wherein* Cnidus *lies, the elevation of the Pole being thirtie sixe degrees,* Eudoxus *determines the Arctique circle also to be so many degrees from the Pole. In like manner in another Climate, it will bee diverse, according to the diversity of the elevation of the Pole. Thus* Hipparchus ὁδ' ἐν Ἀθήναις ἀειφανὴς κύκλος ἀπέχει ἀπὸ τοῦ πόλου μοίρας λζ. ὁδ' ἐν Ῥόδῳ μοίρας λς. *At* Athens *(saith he) the greatest of the Circles alwayes appearing is distant from the Pole thirtie seven degrees: but that in* Rhodes *thirtie sixe degrees: and looke how great the Altitude of the place is, the same must the distance necessarily be betwixt the Pole and that point, by which the Arctique circle is described. And therefore the Ancient Greekes alwayes defined the Arctique circle to be,* τὸ ἀρκτικώτατον σημεῖον τοῦ ὁρίζοντος. *sive* τὸ ἀρκτικώτατον τῆς οἰκήσεως σημεῖον. *The most Northerne point that their Horizon, or place of habitation had. So that the Arctique circle is nothing else, but the point of their habitation which toucheth*

eth the Horizon. For in deſcribing, they have both on common point. Only in this they differ, that the center of the Arctique circle is the Pole of the world; but the center of the Horizon is the Verticall circle, or Zenith of the place.



As for example. A. F. D. E. is the Horizon: A. G. C. H. the Arctique circle A. D. the Meridian: A. the point of Interſection of the Horizon with the Meridian; in which place alſo the Arctique and Horizon in deſcribing doe mutually touch each other. B. the Pole: C. the Zenith of the place. I. the oppoſite point of the diameter of the Arctique circle. Now if the elevation of the Pole bee full 45. degrees, as it is at Vienna in France, then the point I. will be the ſame with C. that is to ſay, the oppoſite part of the Arctique circle will touch the Zenith of the place. But if the elevation of the Pole be leſſe then 45.

degrees, the Zenith will then fall without the circle; but if it be greater, it will fall within. So that by this meanes it will come to passe, that the neerer we are to the Æquator, the lesser these circles will be: and contrariwise, the farther we live off the Æquator, the greater they are: But under the Æquinoctiall it selfe, that is in a right position of Sphære, there is no Arctique circle at all: Pytheas *writes, that those that inhabite* Thule, *now called* Iseland, *have the Tropicke for their Arctique circle. Whether therefore this circle fall within, or without the Tropicke, the distance of it from the point,* I. *will be as great, as is the difference betwixt the elevation of the Pole, and the elevation of the Æquinoctiall above the Horizon of the place. As for example: The elevation of the Pole at* Rome *is* 41. *gr. therefore the Æquinoctiall is elevated above the Horizon* 48. *gr.* 20. *m. and the difference is* 7. *gr.* 40. *m. And therefore the* Zenith, *or verticall point of* Rome, *falleth* 7. *gr.* 40. *m. without the circumference of its Arctick circle. So this distance with those that inhabite* Iseland, *is* 43. *gr. as having their Pole elevated* 66. *gr.* 30. *m. So that the Tropicke with them toucheth the very point of intersection of the Meridian and Horizon. And therfore* Martianus Capella *defines the Arctick circle to be.* Semper apparens, & contingens confinia Finitoris, nunquam mersus assurgens. *A circle that alwayes appeareth, and toucheth upon the skirts of the Horizon, yet never goeth under it. By these words* Confinia Finitoris, *hee meaneth the intersection of the Horizon and Meridian,*

Meridian, ἐν σημείῳ ἀρκτικωτάτῳ, in the most Northerly point.

These grounds being thus laid, we see that as many habitations as there are, so many Arcticke circles there are also, and the same not ἀμεταπτώτους, fixed and unchangeable, but different according to the diversity of places. So that by this we may plainely perceive the errour of our moderne Artificers, who in their Artificiall Globes describe this circle contrary to the doctrine and practise of the Ancients, drawing it on the Poles of the Ecliptique about the Pole of the world. For such an Arcticke circle there cannot be, but only to those that inhabite Syene by the Nile: for with them the Pole is elevated 23. gr. 30. m. These things considered, the Arcticke circle ought not to have any place in the Materiall Globe, unlesse it bee made for the inclination of some certaine place: otherwise there can be no such Arcticke circle.

These things when I first proposed in Aquitaine, where were many, both learned and unlearned, Noble and Padants, it cannot be imagined with what scorne and hissing they entertained them. And at length when my constancy would not give place to their stubborne ignorance; I thought I should have beene beaten among them. Yet at last, having nothing to defend themselves with, they said, that, however it were, these circles were usefull for the distinction of the Zones. At which answer of theirs, I had much adoe to forbeare laughing. For this division of the world into Zones is quite cashiered in these our times, when as the whole world hath at length beene fully discove-

red by the *Navigations of the* Portugals *and* Spaniards. *And for this purpose, to confute these Mathematicians, I alledged those words of* Strabo. ὁ δὴ Πολύβιος οὐκ εὖ, τὸ ποιεῖν πέντε ζώνας τοῖς ἀρκτικοῖς διορίζομένας, δύο μὲν τὰς ἀνωτάτω ἀφ' αὑτοῖς, δύο δὲ τὰς τούτων καὶ τῶν τροπικῶν. εἴρηται γὰρ ὅτι τοῖς καθόλου σημείοις οὐκ ὀφείλει τὰ ἀμετάπτωτα. Polybius *therefore did not well, (saith he) in making certaine Zones, which are to be limited by the Arcticke circles: two of which lie under the said Arctiques, and two other terminated betwixt the Arctiques and the Tropiques. For this is a Maxime: that determinate things cannot bee bounded by uncertaine and indeterminate limits. This their Philosophy therefore is vaine and frivolous. But yet their impudence ends not so. For you shall hardly meet with any of these Mathematicians, that will not presently conclude him madde, that should but dare to discent any whit from the doctrine of* Iohn de Sacrobosco, *in the point of these circles. Yet one of them not long since, being as it seemes, advised thereto by the former edition of* Manilius, *confesseth by the way, and as it were unwillingly, that the Ancients made other use of the Arcticke circles, then wee now doe. And yet he would not be thought to have learned this of me: notwithstanding these kind of fellowes are the most ignorant in matters of Antiquity in the world. Who should be the first broacher of this ridiculous conceit, I cannot guesse, otherwise, then that it must needes be some latine Writer, and that 400. yeares later then any of the Greeke Authors. And I know not whether*

any

any other taught this doctrine before Iohn de Sacroboſco: *certainely he is the moſt ancient I can readily thinke on. As therefore our men are in an errour, in making the Arcticke to be an Immutable circle, ſo likewiſe are the Ancients, and thoſe among us that follow them, to be blamed, for making this circle to be Parallel to the other three: whereas the Parallel circles in a Sphære have the ſame Pole with the Sphære it ſelfe. But the Pole of the Arctique is the ſame alwayes with the Pole of the world: whereas the Pole of the other three altereth, as doe the Tropicall and Æquinoctiall points. For the Æquinoctiall and Tropicall points doe anticipate their places in the Zodiaque: inſomuch that in a certaine tearme of yeares they are removed forward a degree. Now the Æquinoctiall and Tropicall circles, are no other then what are deſcribed by thoſe points, which in themſelves are moveable. Therefore are their Poles alſo moveable. But wee ſhall ſuffer for theſe things too, I doubt not, untill that length of time ſhall have beaten this into the heads of ſuch men, with whom ſtrength of reaſon is able to prevaile nothing at all.*

And this is the opinion of Scaliger, *and the Ancients, concerning the Artique circles: which* Iohannes Pincierus, *a learned man, in his* lib. 2. cap. 13. Parergor. Otij Marpurg. *hath lately examined, and endeavoured to confute the Arctique circle (ſaith he) is thus deſcribed by* Proclus. Arcticus circulus, &c. *The Arctique circle is the greateſt of all thoſe circles that are alwayes in ſight, and it toucheth the Horizon in*

one

one point, and is seene all above the earth. And the Antarctique he defines thus. The Antarctique is a circle equall and Parallel to the Arctique, and lies wholy hid under the earth. These circles therefore, in the opinion of Proclus, are moveable, and are described by a point that toucheth the Horizon about the Pole that is neareſt to it: and they are also changed, with the Horizon, as often as a man moveth either Northward or Southward. So that the nearer they are to the Pole, the leſſe they are: and so contrariwiſe the farther off they are from the same, they are so much the greater: and consequently it followes, because they have no fixed places, that therefore they cannot be described upon a Sphære or Globe.

But from hence there ariseth three inconveniencies. First, that these Arctiques described by Proclus, are not of any use in distinguishing the Frigid Zone from the Temperate, by reason of their uncertaine situation, and mutability. The next is, that with those that inhabite within twentie three degrees and an halfe of the Pole, (which is as much as the Sunnes greateſt declination from the Æquator) the Arctique circle will bee the same with the Tropique of Cancer, and the Antarctique with that of Capricorne. So that they will have but two leſſer circles or Parallels, which will make but three Zones in all, two cold ones, and a torrid. For in this confusion of the circles, there will bee no distinction betwixt the cold, and the temperate Zones. And which is more, they that dwell under the Æquator, will have

no

no Arctiques at all. Lastly, there are certaine accidents proper to certaine Climates, which cannot bee assigned them, unlesse there bee fixed and certaine limits set to distinguish the cold Zones from the temperate.

As for example: If it bee enquired, what properties are incident to those that inhabite betwixt the Tropique of Cancer and the Arctique circle: and what to those under the Arctique circle it selfe: and lastly what betwixt the Arctique circle, and the Pole of the world. To these questions there can bee no answer made without these fixed Arctique circles. Besides this, it would take away much light and furtherance, both from Geographicall Maps, and Astronomicall instruments, if these Arctique circles might not bee described in them: which could not possibly bee described in them, but that they must change evermore with the Horizon.

These and the like inconveniencies are easily avoided, by placing the Arctique circle, as usually it is, on the Poles of the Zodiaque. Neither am I any way swaied with the Authority of Ioseph Scaliger, adhering to Proclus his Doctrine of the mutability of the Arctique Circle: although I am not ignorant, how rare a thing it is, for such a Judgement, matched with so great knowledge, to fall into an errour. And as for that testimonie which they bring out of Strabo, lib. 2. Geogr. that it is sufficient, if there be Arcticke circles in the temperate Climes, and that those that have [illegible]y, have

have not all the same: this is οὐδὲν πρὸς ἔλεγχον *(to use* Straboes *own words) nothing to the argument in hand, and concludes nothing. For then they should bee of no use at all. I cannot therefore assent to a man, whose Tenet is dissonant both from the nature of the thing, and reason it selfe.*

But to retinrne at length to Proclus: *who seeing that hee acknowledgeth that there are five Zones: two of which are terminated betwixt the Poles and the Arctique and the Antarctique circles: and other two bordering upon the same which are the two temperate Zones, and are bounded on one side by the Arctique, and on the other by the Tropickes: betwixt both which lieth the Torrid Zone: hee himselfe seemes tacitely to approve these Immoveable Arctiques, without which there can bee no set constant limits of the Frigid and temperate Zones.*

Thus Scaliger *and* Pincierus. *Now concerning the opinion that the Ancients had of these Zones, namely that some of them were inhabited through extreame cold, and some through parching heat: notwithstanding these are discovered at length to be but vaine dreames, by the late Sea-voyages both of the* Portugals *and our owne Countrimen: yet can it not be denied, but that in each of them there are certaine speciall and peculiar Occurrences. So that, if but for doctrine sake, it were good that these circles should not bee taken away. Neither are wee to despise it, if by the industry of later times, any thing hath beene added to the inventions of the Ancients, which may any whit bee usefull for the instruction*

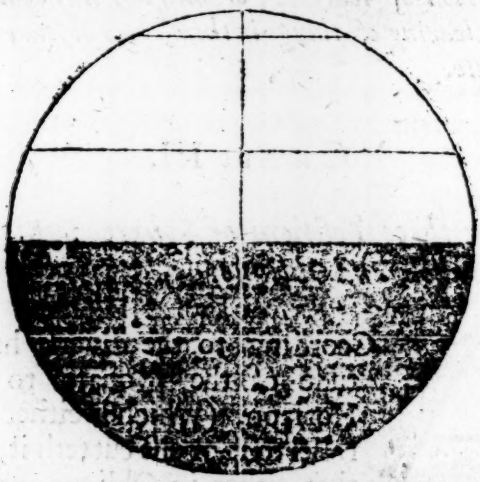
inſtruction of learners, or may any way conduce to the clearing of things in themſelves obſcure and intricate.

Chap. III.

Of the three Poſitions of Sphære : Right, Parallel, and Oblique.

According to the diverſe habitude of the Æquator to the Horizon, (which is either Parallel to it, or elſe cutteth it, and that either in Oblique, or elſe in Right Angles,) there is a threefold Poſition or ſituation of Sphæres. The firſt is of thoſe, that have either Pole for their Verticall point: for with theſe the Æquator and Horizon are Parallel to each other, or indeed rather make but one circle betwixt them both. The 2^d^. is of thoſe whoſe *Zenith* is under the Æquator. The third agreeth to all other places elſe. The firſt of theſe ſituations is called, a Parallel Sphære: the ſecond a Right: and the third an Oblique Sphære. Of theſe ſeverall kindes of poſition, the two firſt are ſimple: but the third is manifold and diverſe, according to the diverſity of latitude of places. Each of theſe have their peculiar properties.

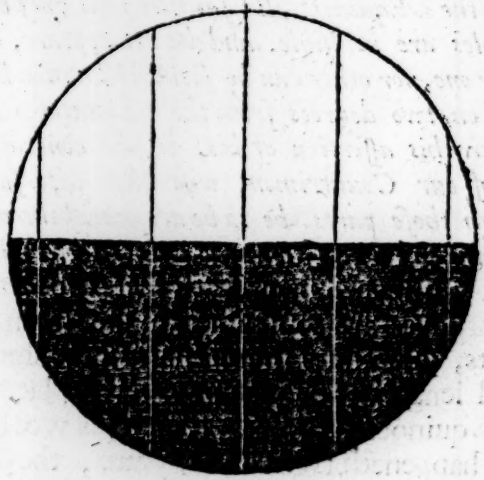
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Thoſe that inhabite in a Parallel Sphære, ſee not the Sun or other Stars, either riſing or ſetting, or higher or lower, in the diurnall revolution. Beſides, ſeeing that the Sun in his yearly motion traverſeth the whole Zodiaque, wch is divided by the Æquator into 2. equall parts: one whereof lieth toward the North, and the other toward the South: by this means it comes to paſſe, that while the Sun is in his courſe through thoſe ſignes that are neareſt their Verticall Pole, all this while hee never ſetteth, and ſo maketh but one continued Artificiall day; which is about the ſpace of ſixe moneths. And ſo contrariwiſe, while he runneth over the other remoter ſignes, lying toward the Oppoſite Pole, hee maketh a long continuall night of the like ſpace of time, or thereabout. Now at ſuch time as the Sun in his diurnall revolution ſhall come to touch the very

very Æquator, he is carried about in ſuch ſort, as that hee is not wholy apparent above the Horizon, nor yet wholy hidden under it: but as it were, halfe cut off.

The affections of a Right Sphære are theſe. All the Stars are obſerved to riſe and ſet in an equall ſpace of time: and continue as long above the Horizon, as they doe under it. So that the day and night is alwaies here of equall length.



PONT. *That in a Right Sphære all the Stars doe both riſe and ſet, that is, are all generally ſeene above the Horizon, and in like manner doe alſo all ſet by turnes; ſo likewiſe that both the Poles, both Arctique and Antarctique may be ſeene at once: hath hitherto beene the received opinion both of* Geminus, *and* Proclus, *and generally of all other Writers: Which our Author alſo here followeth.*

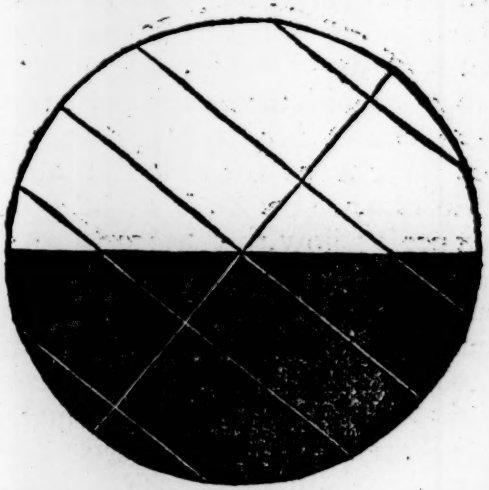
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Yet if we doe but examine the matter more nearely, we shall find this to agree not so much with the Sensible, as with the Rationall or Intelligible Horizon. For as much as even in a Right Sphære, the sight can hardly reach both the Poles, by reason of the extuberancy of the earth. Which is also confirmed by the Testimony of Iohannes Lerius *a* Burgonian, *who in his history of his voyage into the New World, writeth thus.* Non modo sub Æquinoctiali polus uterque non apparet, &c. *Under the Æquinoctiall (saith he) not only both the Poles are invisible, and doe not appeare, but neither one, nor other can be seene, till a man hath passed on two degrees from the Æquator. But whither this assertion of his, or the contrary of some of our Countrimen, who have also sailed through those parts, be to be accounted the more accurate and true, I leave to other to determine.*

An Oblique Sphære hath these properties. Their dayes are sometimes longer then the Nights, sometimes shorter, and sometimes of equall length. For when the Sun is placed in the Æquinoctiall points, which (as wee have said) happeneth twice in the yeare; the daies and nights are then equall. But as he draweth nearer to the elevated Pole, the dayes are observed to increase, and the nights to decrease; till such time as hee comes to the Tropique, when as he there maketh the longest dayes and the shortest nights in the yeare. But when he returneth toward the Opposite Pole, the dayes then decrease, till he toucheth the Tropique that lieth neerest the same Pole:

at

at which time, the nights are at the longeſt, and the dayes ſhorteſt. In this poſition of Sphære alſo, ſome Stars are never ſeene to ſet; ſuch as are all thoſe that lie within the compaſſe of a Circle deſcribed about the Elevated Pole, and touching the Horizon: and ſome in like manner are never obſerved to appeare above the Horizon: and theſe are all ſuch Starres as are circumſcribed within the like circle drawne about the Oppoſite Pole.



Theſe Parallel circles (as wee have ſaid) are thoſe which the Greekes, and ſome of the Latines alſo, call the Arctique and Antarctique circles, the one alwayes appearing, and the other alwayes lying hid. All the other Starres, which are not comprehended within theſe two circles, have their riſings and ſettings by courſe. Of which thoſe that are placed be-

betweene the Æquator and this alwayes-apparent circle, continue a longer ſpace in the upper Hemiſphære, and a leſſe while in the lower. So on the contrary, thoſe that are nearer to the Oppoſite circle, are longer under the Horizon, and the leſſe while above it. Of all which Affections this is the cauſe. The Sunne being placed in the Æquator, (or any other Starre) in his daily revolution deſcribeth the Æquinoctiall circle: but being without the Æquator, he deſcribeth a greater, or leſſer Parallel, according to the diverſity of his declination from the Æquator. All which Parallels, together with the Æquator it ſelfe, are cut by the Horizon, in a Right Sphære, to right angles. For when the Poles lie both in the very Horizon, and the *Zenith* in the Æquator: it muſt needs follow, that the Horizon muſt cut the Æquator in right angles, becauſe it paſſeth through its Poles. Now becauſe it cutteth the Æquator at right angles; it muſt alſo neceſſarily cut al other circles, that are Parallel to it, in right angles: and therefore it muſt needs divide them into two equall parts. So that if halfe of all theſe Parallels, as alſo of the Æquator, be above the Horizon, and the other halfe lye hid under it: it muſt neceſſarily follow, that the Sunne, and other Starres muſt bee as long in paſſing through the upper Hemiſphære, as through the lower. And ſo the daies muſt be as long as the nights; as all the Stars in like manner will bee 12. houres above the Horizon, and as many under it. But in an Oblique

lique Sphære, becauſe one of the Poles is elevated aboue the Horizon, and the other is depreſſed under it: all things happen cleane otherwiſe. For ſeeing that the Horizon doth not paſſe through the Poles of the Æquator, it will not therefore cut the Parallels in the ſame manner, as it doth the Æquator: but thoſe Parallels that are neareſt to the elevated Pole, will have the greateſt portion of them above the Horizon, and the leaſt under. But thoſe that are neareſt the oppoſite Pole, will have the leaſt part of them ſeene, and the greateſt part hid: only the Æquator is ſtill divided into two equall parts, ſo that the conſpicuous part is equall to that which is not ſeene. And hence it is that in all kinds of Obliquitie of Sphære, when the Sun is in the Æquator, the day and night is alwayes of equall length. And as he approacheth toward the elevated Pole, the dayes encreaſe; becauſe the greater Arch, or portion of the Parallels are ſeene. But when he is nearer the hidden Pole, the nights are then the longeſt, becauſe the greateſt ſegment of thoſe Parallels are under the Horizon. And by how much the higher either Pole is elavated above the Horizon of any place, by ſo much the dayes are the longer in Summer, and the nights in Winter.

PONT. *The poſition or ſituation of Sphære is rightly diſtinguiſhed by our Author, into three kinds, to wit, Parallel, Right, and Oblique. Notwithſtanding* Clavius, *with* Sacroboſco, *acknowledge onely two: and they are, Right and Ob-*

lique. For if it be demanded, (*saith* Clavius) *what manner of Sphære they may be said to have, that inhabite under the Poles: we must make answer, an Oblique. But both* Clavius, *and* Sacrobosco *are herein deceived. For those that have such a position of Sphære, as that they dwell under the Pole, the Æquator with them doth not make Oblique angles with the Horizon: because the Horizon and Æquator there make both but one circle. This kinde of Sphære therefore may more rightly be called a Parallel, or Neutrall Sphære: because that its Verticall point falleth upon the Pole of the Sphære. But* Ioseph Scaliger *hath given it the apteſt appellation of all, in his Notes upon* Manilius, Astronom. lib. 3. *upon these Verses.*

Stantis erit cæli ſpecies, laterúmque meatus
Turbinis in morem rectâ vertigine currit.

Where he saith, that every Sphære may be said, aut jacere, ſedere, aut ſtare, *either to lye, sit, or stand. So that the first position of Sphære is, as of lying all along, which is that of a Right Sphære, where the Horizon makes right angles with the Æquinoctiall. The second is of sitting,* τῆς ἐγκλιμένης. *The third is of standing,* τῆς μυλοειδοῦς *and is like a Mill: For in this Position, the Æquinoctiall supplying the office of the Horizon, and as it were turned round about, is just like a Hand-mill, both in habit, and manner of turning about. But we cannot so properly call it a Right Sphære, because of the Right Angles that it makes with the Æquinoctiall, as passing through its Poles: because that that appellation seemes to suite more*

fitly

fitly with a ſtanding Sphære, in which the Æquinoctiall is the ſame with the Horizon and Arctique circle. Laſtly, there is but one Right, or Lying Sphære, becauſe there is but one Æquinoctiall: and there are but two ſtanding Spheres; becauſe there be but two Poles. But there is great variety and diverſities of Oblique, or ſitting Spheres, as may manifeſtly appeare to any man; and as our Author hath declared at large.

CHAP. IIII.
Of the Zones.

THe foure leſſer Circles, which are Parallel to the Æquator, divide the whole earth into 5. parts, called by the Greekes Zones. Which appellation hath alſo beene received, and is ſtill in uſe among all our Latine Writers: notwithſtanding they ſometimes alſo uſe the Latine word, *Plaga*, in the ſame ſignification. But the Greekes do ſometimes apply the word *Zona*, to the Orbes of the Planets, (in a different ſenſe then is ever uſed by our Authors) as may appeare by that paſſage of *Theon Alexandrinus*, in his Commentaries upon *Aratus*. ἔχει γὰρ ὁ οὐρανὸς ζ ζώνας, οὐκ ἐπιζαύσας τῷ ζωδιακῷ· ὧν τὴν μὲν πρώτην ἔχει ὁ Κρόνος. τὴν δὲ δευτέραν ὁ Ζεύς. that is: There are alſo in the heavens ſeven Zones, which are not contiguous to the Zodiaque: the firſt whereof is aſſigned to *Saturne*, the ſecond to *Iupiter*, &c.

Of theſe five Zones, three were accounted

by the Ancient Philosophers and Geographers to bee inhabitable and intemperate. One of them by reason of the Sunnes beames continually beating upon the same: and this they called the *Torrid Zone*, and is terminated by the Tropiques on each side. And the other two by reason of extreame cold they thought could not be inhabited, as being so remote from the heate of the Sunnes beames: whereof one was comprehended within the Arctique circle, and the other within the Antarctique. But the other two were accounted temperate, and therefore habitable, the one of them lying betwixt the Arctique circle and the Tropique of *Cancer*; and the other betwixt the Antarctique and the Tropique of *Capricorne*.

Neither did this opinion, (although in a manner generally received among the Ancients) concerning the number and bounds of the Zones, even then want its opposition. For *Parmenides* would have that Zone, which they call the Torrid, to be extended farre beyond the Tropiques: so that he made it almost as large againe as it ought to have beene: but is withall reprehended for it by *Posidonius*, because he knew that above halfe of that space which is contained betwixt our Summer Tropique and the Æquator, was inhabited. So likewise *Aristotle* terminated the Torrid Zone betwixt the Tropiques, and the temperate Zones with the Tropiques and the Arctique and Antarctique circles. But he also is taxed by the same *Posidonius*, in that he appointes the

Arctique

Arctique circles, which the Greekes will have to be mutable, to be the limits of the Zones. *Polybius* makes ſixe Zones, by dividing the Torrid into two parts, and reckoning one of them from the Winter Tropique to the Æquinoctiall, and the other from thence to the Summer Tropique. Others following *Eratoſthenes*, would have a certaine narrow Zone, which ſhould be temperate and fit for habitation, under the Æquinoctiall line: of which opinion was *Avicen* the *Arabian*. And ſome of our Moderne Writers, (as *Nicolaus Lyranus*, *Thomas Aquinas*, and *Campanus*) I know not upon what grounds, will have the terreſtriall Paradiſe, ſpoken of in the beginning of *Geneſis*, to be placed under the Æquinoctiall line. And ſo likewiſe *Eratoſthenes* and *Polybius* would have all that which they call the Torrid Zone, to be temperate. In like manner *Poſidonius* contradicted the received opinion of the Ancient Philoſophers, becauſe he knew that both *Syene*, which they place under the Tropique of *Cancer*, and alſo *Æthiopia*, which lieth more inward, and over whoſe heads the Sun lieth longer, then it doth upon theirs under the Æquator, are notwithſtanding inhabited. Whence he concluded, that the parts under the Æquinoctial were not unhabitable, becauſe he ſaw that thoſe under the Tropique wanted not inhabitants. Yet *Ptolomy* in his 2^d^. booke and ſixe Chapter of his *Almageſt*, conceiveth all thoſe things, which are reported of the temperateneſſe under the line, to be rather con-

jecture then truth of story: and yet in the last Chapter of his fifth booke of his *Geography*, he describes us a Country in *Æthiopia*, which he calleth *Agisymba*, and placeth farre beyond the *Æ*quinoctiall: (notwithstanding some of our Moderne Geographers sticke not to place it Northward from the *Æ*quator, contrary to *Ptolomies* mind.) This inconstancy of *Ptolomy* hath given occasion to some to suspect, that the *Almageſt*, and *Cosmography* were not the same Authors workes.

Now as concerning these conceits of the Ancients, about the number of the intemperate Zones, if they were not sufficiently proved to bee vaine and idle, by the authority of *Eratosthenes* and *Polybius*: yet certainely it is very evidently demonstrated by the Navigations both of the *Portugals*, and also of our own Countrymen, that not only that tract of land, which the Ancients call the Torrid Zone, is fully inhabited; but also that within the Arctique circle, above 70. degrees from the *Æ*quator, all places are full of inhabitants. So that now no man needs to doubt any further of the truth of this; unlesse he had rather erre with Sacred and Venerable Antiquity, then be better informed by the experience of Moderne Ages, though never so strongly backed with undeniable proofes and testimonies.

PONT. *Whereas our Author accuseth* Ptolomy *of inconstancy, in that in his* Almageſt. cap. 6. lib. 2. *he accounts it a fable rather than any true*

true history, whatsoever is reported of the inhabitants under the Æquator: whereas in his Geography lib. 5. cap. ult. he seemeth to contradict the same: I think that Pliny also is not free from the like fault. For whereas in his lib. 6. cap. 22. having discoursed of the Magnitude of the Isle Taprobane, (which is now thought to be Sumatra, and lyeth directly under the line,) out of Eratosthenes and Megasthenes; he presently addes, that besides the testimony of the Ancients, the Romans had better knowledge of the same, in the time of the Emperour Claudius, there being Embassadors sent from thence to Rome; who among other things should relate, that with them Gold and Silver was in high account, and that they had greater wealth then the Romans themselves; but yet that the Romans had greater use of riches, then they. Which words of Pliny, with many other there at large set downe by him, if they bee but compared with what himselfe elsewhere writeth, in his 2d. booke cap. 68. he will be found manifestly to contradict himselfe. For disputing in this place, and inquiring, how great a part of the earth is inhabited: Tres (saith he) terræ partes abstuliſſe nobis cælum, &c. Three parts of the world the Heavens have robbed us of; to wit, the Torrid, or middle Zone, that is, whatsoever lieth betwixt the two Tropiques: and the two outmost or Frigid Zones: that is to say, what ever ground lieth betwixt either Pole, and the Arctique and Antarctique circles. According to that which the Poet sung of old:

Quarum

Quarum quæ media eſt, non eſt habitabilis æſtu.
Nix tegit alta duas.

In Engliſh thus:

The midſt of theſe is not inhabited,
Through heat: and two with ſnow are cõvered.

For this is that which Pliny *meaneth: that thoſe two outward moſt are not habitable, by reaſon of extreamity of cold, nor the other, through too violent heat. But that which is more to be wondred at in ſo great an Author, (who notwithſtanding indifferently tooke up aſwell the common popular fables, as the extravagãt fictions of the Poets alſo,) is that which he very confidently relates out of* Corlius Nepos, *how that one* Eudoxus, *taking Ship in the* Arabian *gulfe, came as farre as the* Gades, *two ſſles upon the confines of* Spaine. *Which voyage if wee ſhould but throughly examine, will be found to be as much, as that all the* Portugals, *and our Countrymen at this day performe in their Sea voyages to the Eaſt* Indies, *when as touching upon the* Cape of good hope, *they twice croſſe the line, and paſſe through the whole Torrid Zone. Not to ſpeake any thing of that which he writeth in his ſixth booke, twentie third Chapter, Namely, that there is never a yeare, that* India *doth not ſucke out of the* Romane *Empire, at the leaſt* 500000. *Seſtercies, by ſending in ſuch commodities, as they ſell to the* Romanes *for an hundred times as much as they are worth in* India. *And that there is yearely Traffique by Shippe through the Red Sea, betwixt them and the* Romanes, *who are faine for their ſafer paſſage, to*

defend

defend themſelves from Pirates, by going provided with bandes of Archers. And here all that can bee ſaid in Plinies *defence, is, that thoſe things which he relates in his ſecond booke, were written by him long before the reſt which followeth: and that at that time theſe* Indian *voyages were not ſo frequently undertaken, or the paſſages ſo well knowne vnto the* Romanes: *eſpecially for that in the bookes following, as namely the ſixth booke, 17. and 23. Chapters, he ſaith, that the whole courſe of the voyage from* Egypt *into* India, *began but then firſt to be diſcovered, when as he was writing the ſame: and that* Seneca *having not long before begun a deſcription of* India, *reckoned up therein 60. great rivers, and 122. Nations, to be contained within the ſame.*

The principall cauſe of the habitableneſſe and fertility of the parts under the Torrid Zone, is, in that the Sun ſhineth upon them but 12. houres: ſo that the nights beeng alwayes as long as the dayes, the coldneſſe of the one doth very much attemperate the exceſſive heate of the other. In like manner, that both the Frigid Zones are habitable, is to be attributed to the Sun, which in his courſe through the ſixe Northerne ſignes of the Zodiaque, never ſets in ſixe moneths ſpace to thoſe that live under 84. degrees of latitude: ſo that by his continuall preſence the extreame rigidity of the Clime is mitigated, and the cold by this meanes diſpelled.

Chap.

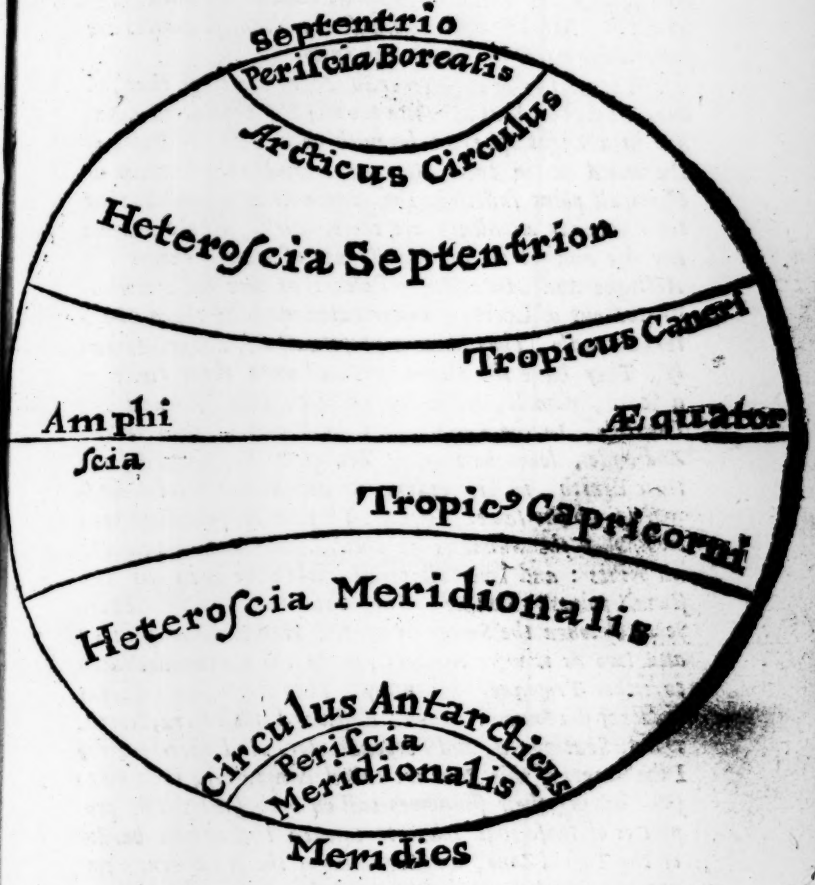
CHAP. V.

Of the Amphiſcij, Heteroſcij, and Periſcij.

THe inhabitants of theſe Zones, in reſpect of the diverſity of their noon-ſhadowes are divided into three kinds, *Amphiſcij*, *Heteroſcij*, and *Periſcij*. Thoſe that inhabite betwixt the two Tropiques are called *Amphiſcij*, becauſe that their noone-ſhadowes are diverſly caſt, ſometime toward the South, as when the Sunne is more Northward then their Verticall point: and ſometimes toward the North, as when the Sun declines Southward from their Zènith.

Thoſe that live betwixt the Tropiques and Arctique circles, are called *Heteroſcij*, becauſe the ſhadowes at noone are caſt only one way, and that either North or South. For the Sunne never comes farther North, then our Summer Tropick; nor more Southward, then the Winter Tropicke. So that thoſe that inhabite Northward of the Summer Tropique, have their ſhadowes caſt alwayes toward the North: as in like manner thoſe that dwell more Southward then the Winter Tropicke, have their Noone-ſhadowes caſt alwayes toward the South. Thoſe that inhabite betwixt the Arctique or Antarctique circles, and the Poles, are called *Periſcij*: becauſe that the *Gnomons* doe caſt their ſhadowes circularly: and the reaſon hereof is, for that the Sun is caried round about above their Horizon in his whole diurnall Revolution.

A figure of all theſe may here be ſeene:



POINT *The* Heteroſciall *Zone is therefore twofold, either Northerne or Southerne. The Northerne is comprehended betwixt the Tropique of* Cancer *and the Arctique circle; and is called* ἑτεροσκιοι Septentrionalis, *becauſe that in it the Sun-beames at noone are alwayes caſt to that part onely that lieth toward the Pole Arctique.*

The

The Southerne Heteroſciall Zone, *containeth all that ſpace of ground that lieth betwixt the Tropique of* Capricorne, *and the Antarctique circle. And it is called* ἑτεροσκιοι, Meridionalis, *becauſe the Noone ſhadowes are projected toward the South Pole onely.*

The properties of theſe ſeverall Zones are theſe that follow. Firſt, they that inhabite the midſt of the Torrid Zone, are in a Right Sphære: for with them both the Poles of the world lie in their Horizon: and their Zenith or Verticall point falleth in the Æquinoctiall Circle. So that their peculiar Accidents are theſe. Firſt, All the Starres doe riſe and ſet in an equall ſpace of time, except the Arctique and Antarctique Poles: as wee have demonſtrated out of Lerius, *in our notes upon the third Chapter. Secondly, They have a perpetuall Æquinoxe. Thirdly, They have the Sunne verticall unto them twice in a yeare, namely, when hee entereth into* ♈ *and* ♎. *Fourthly, In the Sunnes* Periodicall *motion through the Zodiaque, looke how much hee goeth Southward from their Zenith, in his returne he declines as farre Northward from the ſame. Fifthly, They have foure Solſtices; two when the Sunne is in their Zenith and Æquinoctiall points: and two Collaterall, when hee is in the Solſticiall points. Sixthly, They have two Summers every yeare, when the Sunne is in the Æquinoctiall points: and two as it were Winters, when the Sunne declineth to either Tropique. Seventhly, They have five different kindes of ſhadowes: to wit, Eaſtward, Weſtward, Northward, Southward, and Perpendicular. And therefore the Inhabitants of this Zone are called* Amphiſcij, *that is to ſay, having their ſhadowes caſt on both ſides: The properties of thoſe that inhabite toward the utmoſt border of the Torrid Zone, and beginning of the Northerne Temperate, which have an Oblique Sphære, (for the Arctique Pole with them is elevated twenty-three gr. and an halfe, and their Zenith falleth on the Tropique of* Cancer,) *are theſe following. Firſt, All thoſe Starres that are comprehended within the compaſſe of the Arctique Circle, are alwayes above their Horizon: and contrariwiſe thoſe within the circuit of the Arctique alwayes*

lye

lye hid. But of the intermediate Starres thoſe that are Northward from the Æquator, are a longer time above the Horizon, then they are under it: in like manner as the other that decline more Southward, their Nocturnall Arch is greater than the Diurnall: onely thoſe in the line it ſelfe doe riſe and ſet in an equall ſpace of time. 2. Their Artificiall dayes and nights are unequall. 3. The Sunne is in their Zenith but once in the yeare, and that is in the beginning of Cancer: ſo that it never aſcends more Northward, but at all other times is Southward to them. 4. They have two Solſtices: one when the Sun is in the beginning of Cancer, which is their Verticall point: and the other when the Sun entereth into the beginning of Capricorne, at which time the Sun hath the leaſt elevation. 5. They have alſo but one Summer and one Winter. They have foure differences of ſhadowes, namely Eaſterne, Weſterne, Northerne, and Perpendicular. And here is the beginning of the Heteroſcij.

They that dwell in an Oblique Sphære, ſo that the Arctique Pole is elevated with them above 23. gr. and an halfe, but leſſe then 66. gr. and an halfe: their Zenith or Verticall point alwayes falleth betwixt the Tropique of Cancer, and the Arctique Circle: whence they have theſe properties. 1. Very many Starres with them are never obſerved to ſet: for the higher the Pole is elevated, the more Stars there are which alwayes appeare; and ſo in like manner there are as many in the oppoſite Hæmiſphære that never riſe. 2. Their Artificiall dayes and nights are unequall. 3. The Sunne

Sunne is never in their Verticall point: but is alwayes at Noone Southward from them. 4. *They have one Summer, and one Winter, and two Solſtices.* 5. *They have alſo three different kinds of ſhadowes, as namely Eaſtward, Weſtward, and Northward. Whence they are called* Heteroſcij.

Thoſe that inhabite about the end of the Northerne temperate Zone, have the Pole Arctique elevated with them 66. degrees and an halfe: ſo that their Zenith falleth on the Arctique circle: whence they have theſe properties of Sphære. 1. *All the Starres that lye within the Tropique of* Cancer *and the Pole Arctique are of perpetuall Apparition: and contrariwiſe, thoſe that are comprehended within the Oppoſite circle, are never ſeene to riſe.* 2. *When the Sunne is in the beginning of* Cancer, *the Artificiall day is with them twentie foure houres in length: and ſo likewiſe when the Sunne entreth into* Capricorne, *the nights are as long.* 3. *The Sun at noone is alwayes Southward to them: but when he is in the beginning of* Cancer, *and is neare the very Horizon, he then ſeemes in a manner to be Northward.* 4 *They have two Solſtices, and one Summer, and one Winter.* 5. *They have foure differences of ſhadowes: as namely Eaſterne, Weſterne, Southerne and Northerne alſo, eſpecially when the Sunne entreth into the beginning of* Cancer. *About theſe parts the* Heteroſcij *end, and the* Periſcij *begin.*

Thoſe that inhabit about the middle of the Northerne Frigid Zone, have a Parallel or ſtanding Sphære: for the Æquinoctiall is their Horizon, whence they have conſequently theſe properties:

1. *No*

1. *No Starres either riſe or ſet at all: but whatſoever are circumſcribed within the Æquinoctiall circle and the very Pole, are caried about in circles Parallel both to the Æquinoctiall and Horizon.* 2. *For the ſpace of 6. moneths they have one continued day, the Sunne in this ſpace finiſhing his courſe through the Northerne ſignes of the Zodiaque: and ſo likewiſe while he is in the oppoſite meridionall ſignes, they have a night of the ſame length.* 3. *They have but one Solſtice, and that is, when the Sunne entreth into the beginning of* Cancer. 4. *They have one winter and one Summer, or rather inſtead of a Summer they have ſome certaine ſmall remiſſion of the extreamity of cold.* 5. *Their ſhadowes are caried round about them in a circle toward every part of the world: whence they are called* Periſcij, *that is to ſay, having their ſhadowes cared round about in a circular forme.*

Theſe are the properties of the Northerne Zones; which if they bee referred to the oppoſite meridionall parts alſo, you have their properties likewiſe. For whatſoever is ſaid of one Hemiſphære, the ſame is alſo to be underſtood of the other oppoſite Hemiſphære, only in a contrary ſenſe. For when theſe that dwell in the Septentrionall Hemiſphære, have their longeſt day, the oppoſite inhabitants in the meridionall part of the world have their ſhorteſt: and when they have their Summer, with theſe it is then winter, &c. And the ſame is alſo to be underſtood of the other Accidents alſo, concerning their ſhadowes, the riſing and ſetting of the Starres, and the like.

CHAP. VI.

Of the Periæci, Antæci, and Antipodes.

THe Inhabitants of the temperate Zones have by the Ancient Geographers beene divided, in respect either of the same Meridian, or Parallel, or else equal situation in respect of divers parts of the Æquator, in such sort, as that to every habitation in these severall parts, they have added three other different in position, whose inhabitants they called, *Periæci*, *Antæci*, and *Antipodes*.

Periæci are those that live under the same Meridian, and the same Parallel also, being equally distant from the Æquator; but in two opposite points of the same Parallel.

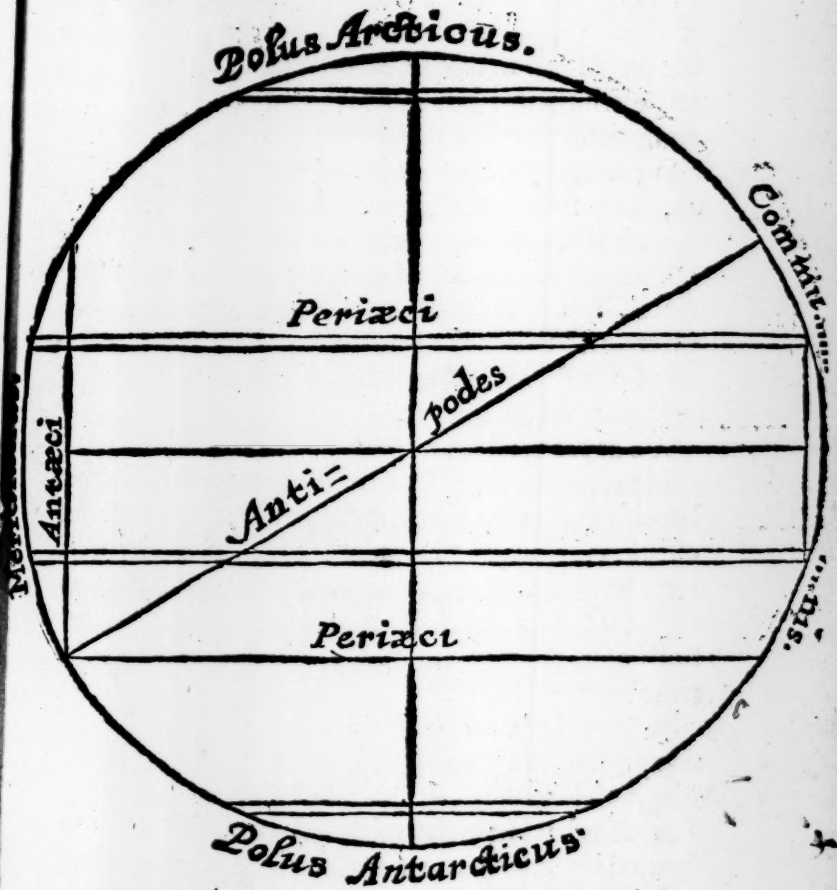
Antæci are such as have the same Meridian, but live in diverse Parallels, yet equally distant from the Æquator, though in diverse parts.

Antipodes, (which are called *Antichthones*) are such as inhabite under one Meridian, but under two diverse Parallels, which are equally distant from the Æquator, and in opposite points of the same: or else wee may define them to be, such as inhabite two places of the earth, which are Diametrically opposite.

They therfore which are *Periæci* in respect of us, are *Antæci* to our *Antipodes*: and those that are *Antæci* to us, are *Periæci* to our *Antipodes*:

and

and our *Periæci*, are *Antipodes* to thoſe which are *Antœci* to us.



We have alſo many accidents common with our *Periæci*. For we both inhabite the ſame temperate Zone; and have Summer, Winter, increaſe and decreaſe of daies and nights at the ſame time. Only this difference is betwixt us, that when it is noon with us, it is midnight with them. Thoſe Authors

that have added this difference alſo, that when the Sun riſeth wth us; it ſetteth with thoſe that are our *Periœci*, have betrayed their own ignorance. For if this were ſo, it would then follow, that when the day is longeſt with us, it ſhould be at the ſhorteſt with them: but this is moſt falſe. They have committed the like errour concerning our *Antœci* alſo; when as they wil have the Sun to riſe with us, and them at the ſame time. The ground of which their errour perhaps may be, in that they conceived us and our *Antœci* to have the ſame Horizon, but that ours was the uppermoſt Hemiſphære, and theirs the lower: the like they conceived of our *Periœci*. But this is an errour unworthy of thoſe that are but meanely verſed in Aſtronomy

We agree with our *Antœci* in this, that we have midday, and midnight both at the ſame time. But herein we differ, that the ſeaſons of the yeare are cleane contrary. For when wee have Summer, they have winter: and our longeſt day, is the ſhorteſt with them. We alſo inhabite temperate *Zones* both of us, though different from each other in the time and ſeaſons.

But with our *Antipodes* all things are quite contrary, both dayes and nights, with their beginnings and endings, as alſo the ſeaſons of the yeare. For at what time we, through the benefit of the Sun, enjoy our Summer and the longeſt day: then is it winter with them, and the daies at the ſhorteſt. So likewiſe when the Sun riſeth with us, it ſetteth with them; and ſo contrariwiſe when it ſetteth with us, it riſeth with them. For we inhabite the upper Hemiſphære, and they the lower, divided by the ſame Horizon.

Chap.

Chap. VII.

Of Climates and Parallels.

According to the different quantity of the longeſt dayes, Geographers have divided the whole earth, on each ſide of the Æquator to the Poles, into Climates and Parallels. A Climate they define to be a ſpace of earth comprehended betwixt any two places, whoſe longeſt dayes differ in quantity halfe an houre. And a Parallel is a ſpace, wherein the dayes increaſe in length a quarter of an houre: ſo that every Climate containeth two Parallels. Thoſe Climates, as alſo the Parallels themſelves are not all of equall quantity. For the firſt Clime, (as alſo the Parallel) beginning at the Æquator, is larger then the ſecond, and the ſecond is likewiſe greater then the third. Only herein they all agree, that they differ equally in the quantity of the longeſt day.

The Ancients reckoned but 7. Climates at the firſt; to which number were afterward added two more; ſo that in the firſt of theſe numbers were comprehended 14. Parallels, but in the later, 18. *Ptolomy* accounting the Parallels by the difference of a quarter of an houre, reckoneth in all 24. by whole houres difference 4. by whole moneths, 6. So that beſides the Æquator, reckoning the whole number of Parallels on each ſide, they amount to 38.

In the Meridian of a Materiall *Globe* there

are described nine Climates, differing from each other by the quantity of halfe an houre. After these there are other also set according to the difference of an whole houre: and last of all those that differ in whole months are continued to the very Pole, each of them expressed in their severall latitudes. The distances of all both Climates and Parallels, together with their latitudes from the Æquator, and differences of the quantity of the longest dayes, are here fully expresst in this Table following.

	Climates.	Parallels.	The longest summers day Hour.	Scr.	Latitude and Elevation of Pole Hour.	Scr.	The breadth of the Climates. Deg.	Scrup.
Amphiscij.	8	0	12	0	0	0	4	18
		1	12	15	4	18		
	1	2	12	30	8	34	8	25
		3	12	45	12	43		
	2	4	13	0	16	52	7	50
		5	13	15	20	33		
	3	6	13	30	23	10	7	3
		7	13	45	27	36		
Heteroscij.	4	8	14	0	30	47	6	9
		9	14	15	33	45		
	5	10	14	30	36	30	5	17
		11	14	45	39	2		
	6	12	15	0	41	22	4	30
		13	15	15	43	32		
	7	14	15	30	45	29	3	48
		15	15	45	47	20		

Heteroſcij.

Climats.	Parallels.	The longeſt ſummers day Hour.	Scr.	Latitude and Elevation of the Pole. Degr.	Scr.	The breadth of the Climates. Degr.	Scr.
8	16	16	0	49	1	3	13
	17	16	15	50	33		
	18	16	30	51	58	2	44
9	19	16	45	53	17		
	20	17	0	54	29	2	17
10	21	17	15	55	34		
	22	17	30	56	37	2	0
11	23	17	45	57	34		
	24	18	0	58	26	1	40
12	25	18	15	59	14		
	26	18	30	59	59	1	26
13	27	18	45	60	40		
	28	19	0	61	18	1	13
14	29	19	15	61	53		
	30	19	30	62	25	1	1
15	31	19	45	62	54		
	32	20	0	63	22	0	52
16	33	20	15	63	46		
	34	20	30	64	6	0	46
17	35	20	45	64	30		
	36	21	0	64	49	0	36
18	37	21	15	65	6		
	38	21	30	65	21	0	29
19	39	21	45	65	35		
20	40	22	0	65	47	0	22
	41	22	15	65	57		
21	42	22	30	66	6	0	17
	43	22	45	66	14		
22	44	23	0	66	20	0	11
	45	23	15	66	25		
23	46	23	30	66	28	0	5
	47	23	45	66	30		
24	48	24	0	66	31	0	0

Periſcij.

	Moneths		
Here the Climates begin to be accounted by months, from 66. gr. 31. m. where the day is 24. houres long: unto the Pole it ſelfe, where it is 6. moneths in length.	1	67	15
	2	69	30
	3	72	20
	4	78	20
	5	84	0
	6	90	0

The ſecond Part,

Chap. I.

Of ſuch things as are proper to the Cæleſtiall Globe: *and firſt of the Planets.*

HItherto hath our diſcourſe beene concerning thoſe things which are common to both *Globes*: We will now deſcend to ſpeake of thoſe that properly belongs to each of them in particular. And firſt of thoſe things that only concerne the *Cæleſtiall Globe*: as namely the Stars, with their ſeverall configurations.

The whole number of Starres hath been divided, by the Ancient Aſtronomers, who firſt applied themſelves to the diligent obſerving of the ſame, into two kinds. The firſt is of the Planets, or wandring Starres: the other of the fixed. The firſt of which they therefore called Planets or Wanderers, becauſe they obſerve no conſtant diſtance or ſituation, neither in reſpect of each other, nor in reſpect of thoſe that are called fixed Starres. And theſe were ſo called, becauſe that they were obſerved

ved alwayes to keepe the ſame ſituation and diſtance from one another, as is at large proved by *Ptolomy*, in his *Almageſt, lib. 7. cap.* 1. out of his owne obſervations, diligently compared with thoſe delivered by *Hipparchus*.

PONT. *The Starres are divided into Planets, or wandering Starres, and fixed: not as if theſe were indeed fixed in one certaine place, and altogether without motion, and the other only moveable and erraticall: but theſe appellations are only given them comparatively; in which ſenſe alſo they are to bee underſtood. For ſeeing that the fixed Starres were obſerved alwayes to keepe the ſame places in the eighth Sphære, and the ſame diſtance from each other: notwithſtanding that they are alwayes in continuall motion, cauſed by the vertue of the firſt Moveable, which carieth them about in the ſpace of twenty foure houres. But the Planets, beſides this motion, have a proper motion of their owne, ſo that they keepe neither the ſame diſtance from the fixed Starres, nor yet the ſame aſpect to each other: for theſe reaſons were the one called Fixed, and the other Planets. For otherwiſe if the Planets be conſidered ſeverally, each one by himſelfe, there is nothing more certaine then their periodicall motions. So that* Tully, *alluding hereto, would have the Planets to bee called* Errantes, *by an* Antiphraſis, quaſi minimè errantes.

The Planets, (excepting thoſe two greater lights, the Sunne and Moone) are five in number

number. All which, beſide the Diurnall motion, by which they are caryed about from Eaſt to Weſt, by the Rapture of the firſt Moveable, have alſo a free proper motion of their owne, which they finiſh from Weſt to Eaſt, according to the ſucceſſion of the Signes, upon the Poles of the Zodiaque, each of them in a ſeverall manner and ſpace of time: Their order in the Heavens, and periods of their motions being ſuch as followeth.

Saturne, called in Greeke Κρόνος, or Φαίνων, (and by *Julius Higinus*, *Stella Solis*, the Starre of the Sunne) is the higheſt of all the Planets: and goeth about the greateſt circuit: but doth not therefore appeare to be the leaſt of all the Planets, as *Pliny* thence conjectured. Hee finiſheth his Periodicall courſe in twenty nine yeares, five moneths, fifteene dayes, according to *Alfraganus*.

Iupiter, in Greeke Ζεύς, and Φαέθων, moveth through the Zodiaque in the ſpace of eleven yeares, tenne moneths, and almoſt 16. dayes.

Mars, Ἄρης and Πυρόεις, (which is alſo called by ſome, *Hercules* his Star) finiſheth his courſe in two yeares.

Sol, the Sunne, in Greeke Ηλιος, performeth his courſe in a yeare, that is to ſay, three hundred ſixtie five dayes, and almoſt ſixe houres.

Venus, Ἀφροδίτη, (called by ſome *Juno's* Starre, by others, *Iſis*, and by others, *The Mother of the Gods*:) when it goeth before

ſore the Sunne, it is called φώσφορος, the day Starre, appearing like another leſſer Sunne, and as it were maturating the day. But when it followeth the Sunne, in the Evening, protracting the light after the Sunne is ſet, and ſupplying the place of the Moone; it is then called Ἕσπερος, the Evening Star. The nature of which Star, *Pythagoras Samius* is ſaid firſt to have obſerved about the thirtie 2d. Olympiad, as *Pliny* relates, *lib.* 2. *cap.* 8. It performeth its courſe in a yeares ſpace, or thereabout: and is never diſtant from the Sunne, above fortie ſixe degrees, according to *Timæus* his computation. Notwithſtanding our later Aſtronomers, herein much more liberall then he, allow it two whole ſignes, or 60. degrees, which is the utmoſt limit of its deviation from the Sunne.

Mercury, in Greeke Ἑρμῆς, and Στίλβων, (called by ſome *Apollo's* Starre) finiſheth his courſe through the Zodiaque in a yeare alſo: And according to the opinion of *Timæus* and *Soſigenes*, is never diſtant from the Sunne above 25. gr. or as our later writers will have it, not above a whole ſigne, or 30. degrees.

Luna, Σελήνη the Moone, is the loweſt of all the Planets, and finiſheth her courſe in twentie ſeven dayes and almoſt eight houres. The various ſhapes and appearances of which Planet, (ſeeming ſometimes to bee Horned, ſometimes equally divided into two halfes, ſometime figured like an Imperfect

perfect circle, and ſometimes in a perfect circular forme,) together with the other diverſities of this Starre, were firſt of all obſerved by *Endymion*; as it is related by *Pliny*: whence ſprung that Poëticall fiction, of his being in love with the Moone.

All theſe Planets are caried in Orbes which are *Eccentricall* to the earth: that is, which have not the ſame center with the earth. The Semidiameter of which Orbes, compared to the Semidiameter of the earth, have this proportion, as is here ſet downe in this Table.

Of what parts the Semidiameter of the Earth is. 1. Of the ſame the Semidiameter of the Orbe of		Is	
	Luna		48. 56. *m.*
	Mercury		116. 3. *m.*
	Venus		641. 45. *m.*
	Sol.		1165. 23. *m.*
	Mars		5032. 4. *m.*
	Jupiter		11611. 31. *m.*
	Saturne		17225. 16. *m.*

The Eccentricities of the Orbes, compared to the Orbes themſelves, have this proportion.

Of what parts the Semidiameter of the Deferent is 60. Of the ſame the Eccentricity of		is		
	Luna		12. 28. *m.* 30. *ſec.*	*Maurolycus, out of Alphonſ.*
	Mercury		2. 0. *m.*	
	Venus		1. 8. *m.*	
	Sol		2. 16. *m.* 6. *ſec.*	
	Mars		6. 0. *m.*	
	Iupiter		2. 45. *m.*	
	Saturne		3. 25. *m.*	

The Eccentricities of ſome of the Planets, (eſpecially of the Sunne) are found to have decrea-

decreased and grown lesse since *Ptolomies* time. For *Ptolomy* sets down the Eccentricity of the Moone to be 12. *gr.* 30. *m.* but by *Alphonsus* it was found to be but 13. *gr.* 28. *m.* and an halfe. *Ptolomy* assigned Eccentricity to *Venus* 1. *gr.* 15. *m.* *Alphonsus* 1. *gr.* 8. *m.* *Ptolomy* found by his owne observations. and also by those that *Hipparchus* had made, that the Eccentricity of the Sun was 2. *gr.* 30. *m.* *Alphonsus* observed it in his time to be but 2. *gr.* 16. *m:* and the 10th. part of a minute. In the yeare of our Lord 1312. it was found to be 2. *gr.* 2. *m.* 18. *sec.* *Copernicus* found it to be lesse yet then that, and to be but 1. *gr.* 56. *m.* 11. *sec.* So that without just cause did the Illustrious *Iulius Scaliger* thinke *Copernicus* his writings for this reason to deserve the Sponge, and the Author himselfe the Bastinado: herein dealing more hardly with *Copernicus*, then he deserves.

PONT. *Besides the Eccentricities of the Planets, it is worth our paines also to observe their Magnides: And this consists especially in the knowledge of their Diameters, and what proportion they beare to each other. For the Diameter of a Planet, compared to the Diameter of the Earth, is after this manner following.*

The Diameter of		compared to the Diameter of the Earth is as			to	
	Saturne		9			2
	Iupiter		32			7
	Mars		7			6
	Sol		11			2
	Venus		3			10
	Mercury		1			28
	Luna		5			17

The

The Diameter of the Sun compared to the Diameter of the Moone, beareth the ſame proportion that is betwixt 187. *and* 10.

And now that which is ſaid may be demonſtrated by an example: let us ſuppoſe the Diameter of the Sun in proportion to the Diameter of the Earth, to be, (as is already ſhewed) as 11. *to* 2. *The Cube therefore of the Sunne is* 11. *and the Cube of the Earth.* 2. *Now theſe Diameters being multiplied cubically, and the greater Cube divided by the leſſe, the difference of their ſeverall* Globes *will appeare. For if you multiply* 11. *by* 11. *there ariſeth* 121. *which number being multiplied againe by* 11. *the whole will be* 1331. *So likewiſe multiply* 2. *cubically, that is to ſay, by it ſelfe, and there riſeth* 4. *which being againe multiplyed by* 2. *ariſeth to* 8. *Now divide the greater Cube,* 1331. *by* 8. *and the product will be* $166\frac{3}{4}$. *which is the difference of the* Globes *of the Sun and the Earth.*

And thus much may ſuffice us to have ſpoken of the Planets: and if any deſire a more copious Narration of the ſame, they may have recourſe to *Ptolomy*, *Copernicus*, and others, that have writen the Theories of the Planets. For a more large deſcription of theſe things ſeemes not to ſtand with our purpoſe: eſpecially for that by reaſon of their Erraticall motion, they cannot be expreſſed in a *Globe*. Let thus much therefore be ſpoken of them, as by the way only.

Chap.

CHAP. II.
Of the Fixed Stars, and their Constellations.

AND here in the next place we intend to speake of the Fixed Stars, and their *Asterismes*, or *Constellations*, which *Pliny* calls *Signa* and *Sidera*, signes. Concerning the number of which Constellations, as also of their figure, names, and number of the Stars they consist of, there is diversity of opinion among Authors. For *Pliny* in his 2^d. book, 41. chap. reckoneth the whole number of the signes to be 72. But *Ptolomy*, *Alfraganus*, and those which follow them, acknowledge but 48. for the most part: notwithstanding some have added to this number one, or two more; as *Berenices Haire*, and *Antinous*. *Germanicus Cæsar*, and *Festus Avienus Rufus*, following *Aratus*, make the number lesse. *Julius Higinus* will have them to be but 42. reckoning the *Serpent*, and *The man that holdeth it*, for one signe: and he omitteth the little *Horse*: and doth not number *Libra* among the signes: but he divideth *Scorpio* into two signes; as many others also doe. Neither doth hee reckon the *Crow*, the *Wolfe*, nor the *South Crowne* among his Constellations, but only names them by the way. The *Bull* also, which was described to appeare but halfe, by *Hipparchus*, and *Ptolomy*, and those that follow them: the same is made to be wholy apparent, both by *Vitruvius*, and *Pliny*, and also before them, by *Nicander*, if we may believe *Theon*, *Aratus* his Scholiast: who also place the *Pleiades* in his backe. Concer-

Concerning the number alſo of the Starres, that goe to the makeing up of each Conſtellation, Authors doe very much differ from *Ptolomy*; as namely, *Julius Higinus*, the Commentator upon *Germanicus*, (whether it bee *Baſſus* as *Philander* calls him: or whether thoſe Commentaries were written by *Germanicus* himſelfe, as ſome deſire to prove out of *Lactantius*) and ſometimes alſo *Theon*, in his Commentaries upon *Aratus*; and *Alfragamus* very often.

Now if you deſire to know what other reaſon there is, why theſe Conſtellations have beene called by theſe names, ſave onely that the poſition of the Starres doth in ſome ſort ſeeme to expreſſe the formes of the things ſignified by the ſame: you may read *Baſſus*, and *Iulius Higinus*, abundantly diſcourſing of this argument out of the fables of the *Greekes*. *Pliny* aſſures us, (if at leaſt we may beleeve him) that *Hipparchus* was the man that firſt delivered to poſterity the Names, Magnitude, and Places of the Starres. But they were called by the ſame names, before *Hipparchus* his time, by *Timochares*, *Aratus*, and *Eudoxus*. Neither is *Hipparchus* ancienter then *Aratus*, as *Theon* would have him to be. For the one flouriſhed about the 420. yeare from the beginning of the Olympiads: as appeareth plainely out of his life written by a Greeke Author. But *Hipparchus* lived above 600. yeares after the beginning of the Olympiads: as his obſervations delivered unto us by *Ptolomy* doe ſufficiently

ently testifie. Besides that there are extant certaine Commentaries upon the *Phænomena* of *Eudoxus* and *Aratus*, which goe under *Hipparchus* his name: unlesse perhaps they were written by *Eratosthenes* (as some rather thinke) who yet was before *Hipparchus*.

PONT. *That which is written of* Hipparchus, *is not to be understood any further, then touching the distinction of the Starres of the first, second, and third magnitude. For so* Servius *in his Commentaries upon the* 1. lib. Geogr. Hipparchus (inquit) scripsit de signis, &c. Hipparchus *(saith he) wrote of the Signes, and reckoned up, how many bright Starres, how many of the second degree of light, and how many obscure Starres there were in each Constellation. For otherwise, that the Starres were knowne by the same names* 1000. *yeares before* Hipparchus, *may be proved out of* Seneca, *who in his* 7. lib. Natural. Quæst. cap. 25. *saith thus.* Nondum sunt anni, &c. *It is not (saith he)* 1500. *yeares yet, since Greece first began to number the Stars, and to give them certaine Appellations, Now* Seneca, *we know, was put to death by the command of* Nero, *in the* 65. *yeare after* Christ. *And* Hipparchus *lived not above* 283. *yeares before* Christ, *in the time of* Ptolomæus Philadelphus. *And* Iob *also, whom* Philo Iudæus *reporteth to have married* Dina, Iacob's *daughter, mentioneth these names,* Arcturus, Pleiades, *and* Orion, *if we may trust St.* Hierom's *translation in this case, cap. 9. vers. 9. Who maketh (saith he)* Arcturus, Orion, *and* Pleiades, *and the*

the Starres in the remotest parts of the South. So likewise the Prophet Amos, *chap. 5. verf. 8.* Quærite (inquit) opificem Pleiadum & Orionis, &c. *Seeke ye him that made the* Pleiades *and* Orion, &c.

Now it is probable, that there were two kinds of men, that reduced the Starres into Constellations: and these might probably be Husbandmen, and Mariners. The Husbandmen perhaps might make these, to wit; the Ram, *the* Bull, *the* Eare of Corne *in the* Virgins hand, *the young* Kids, *the* Goate, *the* Waggoner, *the little* Goate; *the* Waggon: *all which are names used also by* Homer. *Of the Mariners,* the Pleiades, *the* Hyades; *the* Whale, *and the like names seeme to have beene invented; according to that of* Virgil, *in the first of his Georgicks:*

Navita tum Stellis numeros & nomina fecit:
Pleiades, Hyades, clarumq; Lycaonis Arctum.

Which is thus translated into English Verse by T. May.

The Sailers numbred then, and nam'd each Starr
The Pleiads, Hyads, and the Northerne Carre.

And to whom doe those other new Constellations about the Antarctique Pole, owe their now so well knowne names, but to the Portugals, Hollander, *and* English *Sea-faring men? Neither are those men at all to be regarded, that condemne these usuall names of the Starres, and Constellations, as unfit to be used by Christian men. For seeing they are now used, without the least shew of superstition, and that there is very great necessity of these Appellations, in as much*

as without them there could be no agreement or accord in theſe Artes and Sciences (for theſe very names are uſed all the world over, where ever the ſame Artes are taught or profeſſed) I ſee no reaſon but that we may lawfully uſe theſe names, till ſuch time as, the true names, wherewith the great Creator of all things at the firſt called every Star, as David *witneſſeth in the* 146. Pſalme, *be made knowne unto us. As concerning the practiſe of the* Arabians, *who rejecting theſe humane figures, have ſubſtituted in their places the formes of beaſts: you may read* Ioſeph Scaliger, *in his Commentaries upon* Manilius.

Pliny in his 2. *booke*, 41. *chapter* affirmeth, (though I know not upon whoſe authority or credit) that there are reckoned 1600. fixed Starres, which are of notable effect and vertue. Whereas *Ptolomy* reckoneth but 1022. in all, accounting in thoſe which they call *Sporades*, being ſcattered here and there, and reduced to no Aſteriſme. All which, according to their degrees of light, he hath divided into 6. orders. So that of the firſt Magnitude he reckoneth 15. of the ſecond, 45. of the third, 208. of the fourth, 474. of the fifth, 217. of the ſixth, 49. to which we muſt adde the 9. obſcure ones, and 5. other, which the Latines call *Nebuloſæ*, cloudy Starres. All which Starres, expreſſed in their ſeverall Conſtellations, Magnitudes, and names, both Latine and Greeke, (and ſome alſo with the names by which they are called in Arabique) you may ſee deſcribed in the Globe.

Pont.

PONT. *Now as we have already shewed, how by comparing the Diameters of the Planets, with the Diameter of the Earth, their magnitude may be knowne: in like manner also may the magnitude of the fixed Starres be found out: as may be seene by this scheme.*

The Diameter of a Starre of the	1	*is to the Earths Diameter, as*	119	4	
	2		269	60	
	3		25	*to* 6	
	4		19	5	
	5		19	36	
	6		21	8	

Moreover, concerning those other fixed Stars about the Southerne Pole, which were unknowne to Ptolomy *and the Ancients, and now of late yeares discovered by the* Portugals *and* Hollanders; *we shall set downe their names also in their due place.*

All these Constellations (together with their names in Arabique, as we finde them partly set downe by *Alfraganus*, partly by *Scaliger* in his Commentaries upon *Manilius*, and *Grotius* his Notes upon *Aratus* his Asterismes, but especially as *Iacobus Christmannus* hath delivered them unto us out of the *Arabique Epitome* of the *Almageſt*) we will set downe in their order. And if any desire a more copious declaration of the same, we must referre him to the 7. and 8. bookes of *Ptolomies Almageſt*, and *Copernicus* his *Revolutions*, and the *Prutenicke Tables* digested by

Eraſmus Reinholt: where every one of theſe Starres is reckoned up, with his due longitude, latitude, and magnitude annexed.

PONT. *You may alſo ſee* Chriſtophorus Clavius *in his Commentary upon* Iohan. de Sacroboſco, *cap.* 1. *And above all the reſt* Tycho Brahe; *who in his booke of the New Starre that appeared in the yeare* 1572. *hath propoſed tables of the longitude and latitude of all the fixed Starr that can conveniently be ſeene in theſe Climates, according to his owne moſt accurate obſervations: as you may ſee in the aforenamed booke, pag.* 258. *and ſo forward.*

But here you are to obſerve by the way, *Copernicus* and *Eraſmus Reinholt* doe reckon the longitude of all the Starres, from the firſt Starre in *Aries*: but *Ptolomy* from the very Interſection of the *Æquinoctiall* and Ecliptick. So that *Victorinus Strigelius* was in an error, when he ſaid, that *Ptolomy* alſo did number the longitude of Starres from the firſt Starre the head of *Aries*.

CHAP. III.

Of the Conſtellations of the Northerne Hemiſphære.

THE firſt is called in Latine *Vrſa Minor*, and in Arabique *Dub Alaſgar*, that is to ſay, the *leſſer Beare*, and *Alrucaba*, which ſignifieth a *Wagon* or *Chariot*: yet this name is given

given alſo to the hindermoſt Starre in the taile, which in our time is called the Pole Starre, becauſe it is the neareſt to the Pole of any other. Thoſe other two in the taile, are called by the Greekes χορδίται, that is to ſay, *Saltatores*, Dancers. The two bright Stars in the fore part of the body, the *Arabians* call *Alferkathan*, as *Alfraganus* writeth: who alſo reckoneth up ſeven Starres in this Conſtellation, and one unformed neare unto it. This Conſtellation is ſaid to have beene firſt invented by *Thales*, who called it the *Dog*, as *Theon* upon *Aratus* affirmeth.

The ſecond is *Vrſa Major*, the *Great Beare*: in Arabique, *Dub Alacber*. The firſt Starre in the backe of it, which is the 16. in number, is called *Dub* κατ' ἐξοχὴν, and that which is in the flanke, being the 17. in number, is called *Miraë*, or rather, as *Scaliger* would have it, *Mizar*, which ſignifieth (ſaith he) *locum præcinctionis*, the girthing place. The firſt in the taile, which is the 25 in number, is called by the *Alfonſines*, *Aliare*; and by *Scaliger*, *Aliath*. This Aſteriſme is ſaid to have beene firſt invented by *Nauplius*, as *Theon* affirmeth. It hath in all 27. Starres: but as *Theon* reckoneth them, but 24. Both the Beares are called by the Greekes, according to *Aratus*, ἅμαξα, which ſignifieth a *Wagon* or *Chariot*. But this name doth properly appertaine to thoſe ſeven bright Starres in the great Beare, which doe ſomething reſemble the forme of a wagon. Theſe are called by the *Arabians*,

Beneth As; i. e. *Filiæ Feretri*, as *Christmannus* testifieth. They are called by some, though corruptly, *Benenas*, and placed at the end of the taile. Some will rather read it *Benethasch*, which signifies *Filium Vrsæ*. The Grecians in their navigations were wont alwayes to observe the great Beare: whence *Homer* gives them the Epithete ἑλίκωπας as *Theon* observeth: for the Greekes call the great Beare ἑλικὴ. But the *Phœnicians* alwayes observed the lesser Beare, as *Aratus* affirmeth.

The third is called the *Dragon*, in Arabique *Alanin*, and it is often called *Aben*: but *Scaliger* readeth it, *Taben*: whence hee calleth that Starre which is in the Dragons head, and is the 5. in number, *Rastaben*, though it be vulgarly written *Rasaben*. In this Constellation there are reckoned 31. Starres.

The fourth is *Cepheus*, in Arabique *Alrædaf*. To this Constellation, besides those two unformed Starres, which are hard by his *Tiara*, they reckon in all, 11. among which, that which is in number the 4. is called in Arabique *Alderaimin*, which signifieth, the right Arme. This Constellation is called by the the *Phœnicians Phicares*, which is interpreted *Flammiger*, which appellation peradventure they have borrowed from the Greeke word πυρατὴς.

The fifth is *Bootes* βοώτης, which signifieth in Greeke an Heardsman, or one that driveth

Oxen

Oxen. But the Arabians miſtaking the word, as if it had beene written βοωτης of βοάω, which ſignifies *Clamator*, a Cryer, call it alſo *Alhava*, that is to ſay *Vociferator*, one that maketh a great noyſe or clamor: and *Alſamech Alramech*, that is, the Launce-bearer. Betwixt the legs of this Conſtellation, there ſtands an unformed Starre of the firſt Magnitude, which is called both in Greeke and Latine, *Arcturus*, and in Arabique *Alramech*, or the brighteſt Starre, *Somech haramach*. This Starre *Theon* placeth in the midſt of *Bootes* his belt or girdle. The whole Conſtellation conſiſteth of 22. Starres.

PONT. *There is mention made of* Acturus *alſo in* Iob, *cap. 9. verſ. 9. according both to* Hieroms *tranſlation, and alſo the Greeke tranſlation of the* 70. *as we have noted already. But in the Hebrew text it ſelfe, it is called* Gnaſch, *or* Aſch, *from the roote* Gnuſch, *which ſignifieth* Congregabit. Heſychius *in his* Onomaſticon *obſerveth that* Bootes *is alſo called ſometimes Orion: according to that of* Manilius.

Arctos & Orion adverſis frontibus ibant.

In which ſignification H. Grotius *in his notes upon* Aratus *his Aſteriſmes, thinkes it is here to be taken. Sometimes alſo the whole Conſtellation of* Bootes, *or* Arctophylax, *is called* Arcturus; *from the Greeke word* ἄρκτος, *a Beare, and* ὄρος, *which is the ſame that* φύλαξ, *a Keeper: as* Scaliger *upon* Manilius *obſerves. Now that the Hebrewes call* Arcturus *by a word ſignifying a congregating, or gathering together, the reaſon*

I take to be, because he hath the great Beare joyned to him. For this Starre standeth behinde the taile of the great Beare, whence it seemeth to have it's name, quasi ἀρκτοφύλαξ *the keeper of the Beare, whence* Pliny *also*, lib. 2. cap. 41. Bootes sequitur Septentriones.

The sixth Constellation is *Corona Borea*, the North Crowne, called by the *Arabians*, *Aclilaschemali*, and that bright Starre, which is placed where it seemeth to be fastened together, and which is the first in number, is called in Arabique *Alphecca*, which signifieth *Solutio*, an untying or unloosing. It is also called *Munic*: but this name is common to all bright Starres. The whole Constellation consisteth of eight Starres.

The seventh is *Hercules*, in Arabique *Alcheti hale rechabatch*, that is, one falling upon knees, and sometimes absolutely *Alcheti*: for it resembleth one that is wearied with labour (as *Aratus* conceives) whence it is also called in Latine *Nisus*, or *Nixus*; (which in *Vitruvius* is corrupted into *Nesses*:) and the Greekes call it ἐγγόνασιν that is to say, One on his knees. The Starre which is first in number in the head of this Constellation, is called in Arabique *Rasacheti*, not *Rasaben*, as the *Alfonsines* corruptly have it: and the 4. Starre is called, *Marsic*, or rather *Marsic*, *Reclinatorium*, that part of the Arme on which we leane. The eight Starre, which is the last of the three in this Arme, is called *Mazim*, or *Maasim*, which signifieth, *Strength*. This Constellation

tion hath eight Starres, beſides that which is in the end of his right foote, which is betwixt him and *Bootes*, and one unformed Starre at his right Arme.

The eight is the *Harpe*, called in Latine *Lyra*, in Arabique *Schaliaf*, and *Alvakah*, i. e. *Cadens* ſc. *Vulture*, the *Falling Vulture*. It conſiſteth of 10. Starres, according to *Hipparchus* and *Ptolomy*: but *Timochares* attributed to it but 8. as *Theon* affirmeth: and *Alfraganus* 11. The bright Starre in this Conſtellation, being the firſt in number, *Alfonſus* calleth *Vega*.

The ninth is *Gallina*, or *Cygnus*, the Hen, or Swan, and is called in Arabique *Aldigaga* and *Altayr*, that is, the flying Vulture. To this Aſteriſme they attribute, beſides thoſe two informed neare the left wing, 17. Starres, the 5. of which is called in Arabique, *Deneb Adigege*, the taile of the Hen; and by a peculiar name *Arided*, which they interpret, *quaſi redolens lilium*, ſmelling as it were of Lillies.

PONT. *And here in this place it is worth our noting, that there was a new Starre obſerved in the breaſt of the Swanne, in the yeare* 1600. *which ſet many Mathematicians on worke: and among the reſt, beſides* Iuſtus Byrgius *Engineer to the Emperour*, Iohannes Beierus, Maſtline, *and others*: Iohan. Kepler *alſo, who had ſometime beene* Tychoes *Scholler, put forth a Mathematicall Tract of it, when it had now continued in the ſame place of that conſtellation for the ſpace of 6. yeares, being a Starre about the third Magnitude.*

The

The 10th is *Cassiopeia*, in Arabique *Dhath Alcursi*, the Lady in the Chayre: and it consisteth of 13. Starres; among which the 2d. in number *Alfonsus* calleth *Scheder*, *Scaliger Seder*, which signifieth a Breast.

PONT. *There was another new Star also appeared in* Cassiopeia, *being as great as a Starre of the first Magnitude, in the yeare* 1572. *Novem.* 11.th *and it lasted* 11. *Monethes. Of which Starre there were divers opinions among Astronomers: yet they all agreed in this, that it was placed in the seat of* Cassiopeia *in the very Skie, and in* Via lactea. *And those that had observed it more accurately* (*and among the rest the Noble* Tycho Brahe, *who also wrote a large Volume of the same, full of most accurate observations*) *did all of them unanimously confesse, that they could not perceive that it had any* Parallaxe *at all, nor yet distinguish any difference betwixt its True and Apparent place; and also added, that it alwayes kept the same situation in the Eigth Sphære. Whence they manifestly are refuted, who deny that there hath ever any new Starre risen in the heavens since the first Creation: among which is* Lambertus Danæus, *as may appeare in his* Physic. Christian. Tract. 4. cap. 10. *But he ought to have mentioned not this Starre onely, but also that other, which* (*as* Pliny *testifieth*) *was observed by* Hipparchus *to have beene generated in the very Skie it selfe in his time. For whereas the same* Danæus *thinkes, that the Starre which appeared at our* SAVIOURS *Nativity, was either some Comet, or else some one of the Ordinary Stars,*

Stars, which at that time kept an extraordinary courſe in its motion: the firſt of theſe cannot bee granted; becauſe it is expreſly called a Starre: neither is the ſecond of any force, becauſe it is not probable, that the Magi, *who were ſo skilfull in the knowledge of the Stars, ſhould be ſo much deceived, as to miſtake an old ſtarre, that had onely changed its place, for a new one. Neither yet doe we beleeve this to be the ſame that* Hipparchus *is ſaid to have obſerved in his time, or this other, which as we have ſaid, was ſeene* Anno. 1572. *but rather that it was a different Starre from both. For further ſatisfaction whereof, I referre my reader to* Tycho de Nova Stella pag. 319. *&c.*

The 11th is *Perſeus, Chamil Ras Algol,* that is to ſay, Bearing the head of *Meduſa:* for that Starre which is on the top of his left hand, is called in Arabique *Ras Algol,* and in Hebrew *Roſch haſſatan,* the Divels head. This conſtellation hath, beſides thoſe three unformed, 26. other Stars: of which that which is the ſeventh in number, *Alfonſus* calleth *Alchcemb,* for *Alchenib,* or *Algeneb,* according to *Scaliger,* which ſignifieth a ſide.

The 12th is *Auriga,* the Wagoner, in Arabique *Roha,* and *Memaſſich Alhanam,* that is, One holding the raines of a bridle in his hand. This Aſteriſme hath 14. Stars: of which that bright one in the left ſhoulder, which is alſo the third in number, is called in Greeke, αἴξ *Capra,* a Goate; and in Arabique *Alhaiok,* or, as *Scaliger* ſaith, *Alatod,* which ſignifieth a He Goate: and the two which are in his left hand,

hand, and are the 8th and 9th, are called ἔριφοι *Hœdi, Kids*; and in Arabique, as *Alfonsus* hath it, *Saclateni*, but according to *Scaliger*, *Sadateni*, the hindmost arme. This Configuration of these Stars was first observed by *Cleostratus Tenedius*, as *Higinus reporteth*.

The 13th is *Aquila*, *Alhhakkab*, the Eagle: the moderne Astronomers call it, the *flying Vulture*, in Arabique *Altayr*: but *Alfraganus* is of a contrary opinion, for he calleth the Swanne by this name, as wee have already said. They reckon in this Asterisme 9. Stars, besides 6. other unformed, which the Emperour *Hadrian* caused to be called *Antinous*, in memory of *Antinous*, his Minion.

The 14th is the *Dolphin*, in Arabique, *Aldelphin*, and it hath in it 10. Stars.

The 15th is called in Latine *Sagitta*, or *Telum*, the Arrow or Dart, in Arabique *Alsoham*: it is also called *Jstuse*, which word *Grotius* thinkes is derived from the Greeke word ὀιστὸς signifying an arrow. It containeth 5. Stars in all.

The 16th is *Serpentarius* the Serpent-bearer, in Arabique *Alhaya*, and *Hasalangue*. It consisteth of 24. Stars, and 5. other unformed. The first Starre of these is called in Arabique *Rasalangue*.

PONT. *There was also discovered a new Starre in the foot of the Serpent-bearer*, Anno 1605, *which might have beene reckoned among the Stars of the third magnitude. It began first to appeare about* October *in the yeare aforesaid, and*

and about February *the yeare following, being* 1606. *it vaniſhed out of ſight.* Kepler *wrote a Booke of this Starre alſo, unto whom you may have recourſe for further ſatisfaction.*

The 17th is *Serpens*, the Serpent, in Arabique *Alhafa*: it conſiſteth of 18. Stars.

The 18th is *Equiculus*, the little Horſe, and in Arabique *Kataat Alfaras*, that is in Greek, ἡμιτομὴ ἵππου, as it were, the fore part of a Horſe cut off. It conſiſteth of 4. obſcure Stars.

The 19th is *Pegaſus*, the Great Horſe, in Arabique *Alfaras Alathem*; and it hath in it 10. Stars. The Starre on the right ſhoulder, which is called *Almeukeb*, and is the third in number, is alſo called, *Seat Alfaras*, *Brachium equi*. And that which is in the opening of his mouth, and is numbred the 17th, is called in Arabique *Enif Alfaras*, the Noſe of the Horſe.

The 20th is *Andromeda*, in Arabique *Almara Almaſulſela*, that is, the Chained Woman; *Alfraganus* interprets it, *Fœminam, quæ non eſt experta virum*; A Woman that hath not knowen a man. This Conſtellation containeth in it 23. Stars: whereof that which is the 12th in number, and is in the girdling place, is commonly called in Arabique *Mirach*, or, according to *Scaliger*, *Mizar*: and that which is the 5th is called *Alamac*, or rather *Almaac*. which ſignifieth a ſocke or buskin.

The 21th is the *Triangle*, in Arabique *Almutaleh*, and *Mutlathun*, which ſignifies *Triplicity*.

plicitus. It consisteth of 4. Starres.

PONT. *Among all these Constellations in the Northerne Hemisphære, which are in all 21. there are but three Stars onely of the first Magnitude. The first of which is that in the left shoulder of* Erichthonius, *or the Wagoner, called in Latine* Capella. *The second is the bright Star in the* Harpe: *and the third is* Arcturus, *betwixt the legs of* Bootes. *Now the whole number of Stars in this part of the heavens, reckoning in these also which are of the* 2^d. 3^d. 4^th. 5^th. *and* 6^th. *magnitude, with the obscure and cloudy ones also, ariseth to* 360.

CHAP. IV.

Of the Northerne Signes of the Zodiaque.

THE First is *Aries*, the Ram, in Arabique *Alhamel*: this Constellation hath 13. Starres, according to *Ptolomies* account; yet *Alfraganus* reckoneth but 12. besides the other 5. unformed ones, that belong unto it.

The 2^d is *Taurus*, the Bull, in Arabique *Altor*, or *Ataur*: in the eye of this Constellation there is a very bright Star, called by the Ancient Romans *Palilicium*, and by the Arabians *Aldebaram*, which is to say, A very bright Star, and also *Hain Altor*, that is, the Bulls eye. And those five Stars that are in his forehead, and are called in Latine *Suculæ*, the Grecians

Grecians call ὑάδες becauſe, as *Theon*, and *Hero Mechanicus* conceive, they repreſent the forme of the Letter *Y*. although perhaps it is rather becauſe they uſually cauſe raine and ſtormy weather. *Thales Mileſius* ſaid that there were two of theſe *Hyades*, one in the Northerne Hemiſphære, and the other in the South: *Euripides* will have them to be 3: *Achæus* 4, *Hippias* and *Pherecides* 7. Thoſe other 6. or rather 7. Stars, that appeare on the backe of the Bull, the Greekes call *Pleiades*, (perhaps from their multitude) the Latines *Vergiliæ*, the Arabians *Atauria, quaſi Taurinæ*, belonging to the Bull. *Nicander*, and after him *Vitruvius*, and *Pliny* place theſe Stars in the taile of the Bull: and *Hipparchus* quite out of the Bull, in the left foot of *Perſeus*. Theſe Stars are reported by *Pliny* and *Solinus* to be never ſeene at all in the Iſle *Taprobana*: but this is ridiculous, and fit to bee reported by none, but ſuch as *Pliny* and *Solinus*. For thoſe that inhabite that Iſle, have them almoſt over their heads. This Conſtellation hath 33. Stars in it, beſides the unformed Stars belonging to it, which are 11. in number.

PONT. Plines *words in that place doe not ſeeme to carry any ſuch ſenſe ſimply, ſeeing that he addes the ſame alſo of the Beare. His words are theſe in his* lib. 6. cap. 22. *where ſpeaking of certaine Embaſſadours that came from the Iſle* Taprobana *to* Rome, *he ſaith*; Septentriones, Vergiliaſque apud nos, veluti novo cœlo, mirabantur: *They wondred to ſee the Beare, and*

the seven Stars with us, as if they had been arrived in a new world. And certainely if Taprobane *be situate under the very Line, this then, for that very reason we alleadged before on the* 3. cap. par. 1. *out of* Lerius, *had beene no such strange matter, if it had beene spoken of the* Septentriones *onely. Neither had* Pliny *written any so absurd a relation, if he had said thus.* Septentriones apud nos, veluti novo cœlo, mirabantur.

In the meane time I could wish, that Authors would insert nothing in their bookes, without due examination: although I am not ignorant, that it is not strange to finde Pliny *faultering now and then in these kinde of things.*

The third is *Gemini*, the Twinnes, in Arabique *Algeuze*. These some will have to bee *Castor* and *Pollux*, and others, *Apollo* and *Hercules*: whence with the Arabians the one is called *Aselar*, for *Aphellan*; and the other *Abracaleus*, for *Gracleus*: as *Scaliger* conceiveth. It containeth in it, (besides the 7. unformed,) 18. Stars, amongst which that which is in their head, is called in Arabique *Rasalgeuze*.

The fourth is *Cancer*, the Crab, in Arabique *Alsartan*, consisting of 9. Stars, beside 4. unformed: of which that cloudy one which is in the breast, and is the first of all, is called *Mellef* in Arabique, which, as *Scaliger* saith, signifieth thicke or well compact.

The fifth is *Leo*, the Lion, in Arabique *Alased*: in the breast whereof there is a very bright Starre, being the 8th in number, and is called in

in Arabique *Kale Alaſed*, the heart of the Lion, in Greeke βασιλίσκος, becauſe that thoſe that are borne under this Starre, have a Kingly Nativity, ſaith *Proclus*. And that which is in the end of the taile, and is the laſt of all in number, is named *Deneb Alaſed*, that is to ſay, the taile of the Lion: *Alfraganus* calleth it *Aſumpha*. This Conſtellation containeth in it 27. Stars, beſides 8. unformed. Of the unformed Stars which are betwixt the hinder parts of the Lion, and the Great Beare, (according to *Ptolomies* account, although *Theon* following *Aratus*, reckons the ſame as belonging to *Virgo*,) they have made a new Conſtellation, which *Conon* the Mathematician, in favour of *Ptolomy* and *Berenice*, would have to bee called *Berenices* Haire: which ſtory is alſo celebrated by the Poet *Callimachus* in his Verſes,

The ſixth is *Virgo*, the Virgin, in Arabique *Eladari*: but it is more frequently called *Sunbale*, which ſignifieth an Eare of Corne: and that bright Starre which ſhe hath in her left hand, is called in Greeke, στάχυς, an Eare of Corne, and in Arabique *Hazimeth Alhacel*, which ſignifieth an handfull of Corne. This Starre is wrongly placed by *Vitruvius* and *Higinus* in her right hand. The whole Conſtellation conſiſteth of 26, Stars, beſides the 6. unformed.

CHAP. V.

Of the Constellations of the Southerne Hemisphære: and first of those in the Zodiaque.

AND first of *Libra*, which is the 7. in order of the Signes. That part of this Constellation which is called the Southerne Ballance, the Arabians call *Mizan Aliemin*, that is to say, *Libra dextra vel meridionalis*, the Right-hand or Southerne ballance. But *Libra* was not reckoned anciently among the Signes: till that the later Astronomers robbing the Scorpion of his clawes, translated the same to *Libra*, and made up the number of the Signes: whence the Arabians call the Northerne ballance, *Zubeneschi mali*, that is in Greeke χηλὴ Βόρειος the NorthClaw, and the other part of it that lookes Southward, they call *Zubenalgenubi* χηλὴ νότιος, the South Claw. This Constellation containeth in it 8. Starres, beside 9, other unformed belonging to it.

The eight is *Scorpio*, the Scorpion, in Arabique commonly called *Alatrab*, but more rightly *Alacrab*: whence the Starre in the breast of it, which is the 8. in number, is called *Kelebalacrab*, that is, The Heart of the Scorpion: and that in the end of his taile, which is the second in number, they call *Leschat*, but more truly *Lesath*, which signifieth the sting of

of any venomous creature, and by this word they underſtand the Scorpions ſting. It is alſo called *Schomlek*, which *Scaliger* thinkes is read by tranſpoſition of the letters, for *Moſclek*, which ſignifieth the bending of the taile. This Conſtellation conſiſteth of 21. Starres, beſides 3. unformed.

The ninth is *Sagittarius*, the *Archer*, in Arabique *Elcuſu*, or *Elcauſu*, which ſignifieth a Bow; it hath in it 31. Starres.

The tenth is *Capricornus*, the Goate, in Arabique *Algecli*. To this Conſtellation they attribute 28. Starres, among which that which is in number the 23. is called in Arabique *Denob Algedi*, the taile of the Goate.

The eleventh is *Aquarius*, the Waterman, in Arabique *Eldelis*, which ſignifieth a *Bucket* to draw water. The 10. Starre of this Conſtellation is called in Arabique *Seat*, which ſignifieth an Arme. It containeth in all 42. Stars.

The twelfth is *Piſces*, the Fiſhes, in Arabique *Alſemcha*. It containeth 34. Starres, and 4. unformed.

PONT. *Among all the Conſtellations reckoned up by the Author in this and the precedent chapters, there are onely found 5. Starres of the firſt Magnitude. The firſt of which, is* Oculus Tauri: *the ſecond,* Cor Leonis; *the third,* Cauda Leonis: *the fourth* Spica Virginis: *and the fift and laſt, is a ſtarre about the mouth of the ſouth Fiſh. The reſt are all either of the 2. 3. 4. 5. or 6. magnitude, beſide ſome certaine cloudy ones; which are reckoned in all to bee* 346.

CHAP. VI.

Of the Constellations of the Southerne Hemisphære, which are without the Zodiacke.

THE first is *Cetus*, the Whale, called in Arabique *Elkaitos*, consisting of 22. Starres. That which is in number the second, is commonly called *Menkar*, but more rightly, as *Scaliger* saith, *Monkar Elkaitos*, the nose or snout of the Whale; and the 14. *Boten Elkaitos*, the belly of the Whale; and the last of all save one, *Deneb Elkaitos*, the taile of the Whale.

The second is *Orion*, which the Arabians call sometimes *Asugia*, the mad man; which name is also applied to *Hydra*: and sometimes *Elgeuze*. Now *Geuze* signifieth a *Wall-nut*; and perhaps they allude herein to the Latine word *Iugula*, by which name *Festus* calleth *Orion*: because he is greater then any of the other Constellations, as a Wall-nut is bigger then any other kinde of nut. The name *Elgeuze* is also given to *Gemini*. This Constellation is also called in Arabique *Algibbar*, which signifies a strong man, or Gyant. It consisteth of 38. Starres, among which that which is the second, and is placed in his right shoulder, is called *Ied Algeuze*, that is, *Orion's* Hand, as *Christmannus* thinketh: but more commonly *Ied Elgeuze*, and perhaps it should rather

rather be *Bet Elgeuze*, that is, the bright Star in *Orion*. The third Starre is called by the *Alfonſines Bellatrix*, the Warrier. That which is in his left foote, and is the 35. in number, is called *Rigel Algeuze*, or *Algibbar*, that is to ſay, *Orions* foote.

PONT. *In the 9. Chap. of* Iob, *verſ. 9. there is mention made of* Orion, *as we ſaid before. Now the word in the Originall is* Keſil, *which ſignifieth Madneſſe, Rage, and Inſtability: and it is ſo called perchance, becauſe that when this Conſtellation riſeth with the* Sunne, *it cauſeth great ſtore of tempeſtuous weather in all places: whence it is ſtiled by the Poet,* Nimboſus & *Aquoſus* Orion. *Now we muſt note, that this word* Keſil *in Hebrew, (which is rendred* Orion *by* Hierome *and others) doth anſwer to the Arabique word* Aſugia, *which ſignifieth likewiſe a Bold or Furious fellow, as our Author ſaith. In like manner there is mention made of* Orion *againe in the* 38. Chapter of Iob, verſ. 31. Nunquid cohibebis delicias Pleiadum, aut lora Orionis diſſolves: *Canſt thou bind the ſweete influences of the Pleiades, or looſe the bonds of Orion? notwithſtanding Interpreters doe not all agree in rendring this place. Looke alſo in the Prophet* Amos, Chap. 5. verſ. 8.

The third is *Eridanus*, in Arabique *Alvahar*, that is to ſay, the River: whence *Nar*, the name of a River in *Hetruria*, is conceived by ſome to have beene contracted. It hath in it 34. Starres: among which that which is the 19. is commonly called in Arabique *Angetenar*,

getenar, but *Scaliger* rather thinkes it should be read *Anchenetenar*, which signifieth the winding or crooking of a River. The 29. Starre is also called *Beemim*, or rather *Theemim*, which signifieth any two things joyned together: so that it is to be doubted, whether, or no this name may not be as well applied to any two Starres standing close by one another. And the last bright Starre in the end of it, is called *Acharnahar*, as if you should say, Behinde the River, or, in the end of the River: and it is commonly called *Acarnar*.

PONT. Avienus *calleth this River* Nilus, *in these verses of his.*

----Pharium pars altera Nilum (amne.
Commemorat, largo segetes quòd nutriat

In English thus.

The other part relates of fruitfull Nile
Whose swelling streames enrich the Pharian Ile.

And Plautus *also hath an elegant* Periphrasis *of the same in his* Trinummus, Scen. Huic ego. *where he speakes thus*: Ad caput amnis, quod de cœlo exoritur sub solio Iovis. *relating it as of a River that should spring out in the Heavens, from under* Iupiters *Throne.*

The fourth is *Lepus* the Hare, in Arabique *Alarnebet*: and it containeth in all 12 Stars.

The fifth is *Canis* the Dogge, *Alcheleb Alachbar* in Arabique, the great Dog; and *Alsahare aliemalija*, that is to say, the Right-hand or Southerne Dog. Which name, *Alsahare*, which is also sometime written *Scera*, *Scaliger* thinkes is derived from an Arabique word,

word, which ſignifieth the ſame that ὑδροφοβία in Greeke, a diſeaſe that mad Dogs are troubled with, when as they cannot endure to come neare any water. Notwithſtanding *Grotius* is in doubt whether or no it ſhould not rather be *Elſeiri*, and ſo derived from the Greeke word σειριος, For by this name is that notable bright Starre called, which is in the Dogs mouth, and is called in Arabique *Gabhr*, or *Ecber*, and by corruption, *Habor*. This Conſtellation hath in it 11. Stars.

The ſixth is the little Dog, called in Greeke *Procyon*, and in Latine *Antecanis*, becauſe it riſeth before the great Dog. The Arabians call it *Alcheleb Alaſgar*, that is to ſay, the leſſer Dog, and *Alſahare alſemalija*, and commonly, though corruptly, *Algomeiza*, the left hand or Northerne Dog. This Aſteriſme conſiſteth of two Stars onely.

PONT. *There is extant a notable witty Epigram in* Auſonius *of the Cœleſtiall, Terreſtriall and Marine Dogs; which may have reference to this place alſo, if ſo be that it be preſented in it's proper meaning after this manner.*

Trinacrij quondam currentem in littoris ora
Antecanis leporem cœruleus rapuit. (eſt:
At Lepus. In me omnis terræ, pelagique ruina,
Forſitan & Cœli; ſi Canis aſtra tenet.

In Engliſh thus.

As once a Hare came lightly tripping o're
The ſandy bankes of the Trinacrian ſhore:
A Dog-fiſh caught her. Whereat ſhe replies.
Land, Stars, and all, are ſtill mine enemies.

Nor

Nor ſhould I yet be more ſecure, I feare,
In Heaven it ſelfe; if Dogs they harbour there.

In which place Antecanis Cœruleus, *in the ſecond verſe, ſignifieth a* Sea-dog. *Yet this place hitherto hath commonly gone thus,* Ante canes leporem, *&c. without any ſenſe at all. Now the Poet in this place uſeth this word* Antecanis, *in imitation of* Tully, *who firſt of all Latine Authors, rendred* Procyon, Antecanis : *as manifeſtly appeareth out of his tranſlation of* Aratus *into Latine verſe.*

The ſeventh is *Argo*, the Shippe, in Arabique *Alſephina* ; now *Sephina* ſignifieth a ſhip. It is alſo called *Merkeb*, which ſignifieth a *Chariot*: according as the Poets alſo uſually cal it, ἅρμα θαλάσσης as if one ſhould ſay, a Sea-chariot, in ſtead of a ſhip. But the *Alfonſines* give this appellation to that Star which is the 6. in number. The whole Aſteriſme containeth in it 45. Stars, of all which, that which is the laſt ſave one, is called in Arabique *Sohel*, or *Syhel*, which ſignifieth Ponderous or weighty. Which Appellation they perhaps have given it, for the ſame reaſon, that *Baſſus* hath another like it, which is, *Terreſtris*, becauſe it alwayes appeareth to them very low, and neare the earth. The Greekes call this Star νότιον Θ, the Hebrewes *Cheſil*, as *Chriſtmannus* is of opinion. Which if it be ſo, then *Arias Montanus* is in an errour, in taking it for *Orion*, in his tranſlation of the Itinerary of *Beniamin Tudelenſis*. The Inhabitants of *Azania* called it an Horſe, as *Ptolomy* affirmes, in his *Geogra. lib.* 5. *cap.* 7. The

The eigth is *Hydra*, in Arabique *Alſugahh*, or *Aſuia*, which ſignifieth Strong, or Furious. The *Ægyptians* called it *Nilus*, as *Theon* writeth in his Commentaries upon *Aratus*. It hath in it, 25. Starres, beſides two unformed: the 12. of which the Alphonſines call *Alphart*.

The ninth is *Crater*, the Cup, in Arabique *Albatina*, and *Elkis*, which ſignifieth a Goblet or ſtanding Cup. It hath in it 7. Stars.

The tenth is *Corvus*, the *Crow*, *Algorab* in Arabique, conſiſting of 7. ſtarres.

The eleventh is *Centaurus*, the Centaure, called by the ſame name in Arabique. It containeth 37. Stars: among which, thoſe that are in his hinder feete, are the Stars that make up the Croſſe, ſo much celebrated in the Spaniſh Navigations.

The twelfth is *Fera*, the Wild-beaſt, called in Arabique *Aſida*, ſignifying a Lioneſſe, and *Alſubahh*, which alſo is taken for a Wolfe, or other ravenous beaſt. To this Conſtellation they reckon 19. Stars.

The thirteenth is *Ara*, or *Thuribulum*, the Altar, or Cenſer, in Arabique *Almugamra*: *Baſſus* calleth it *Sacrarium*. It containeth 7. Stars.

The foureteenth is *Corona Auſtralis*, the South Crowne, in Arabique *Alachil Algenubi*: it conſiſteth of 13. Stars, making up a double wreath, according to *Alfraganus*: yet *Theon* reckoneth but 12. in it.

The fifteenth is *Piſcis Auſtrinus*, the South Fiſh, *Ahaut algenubi* in Arabique. It containeth

taineth in it 12. Starres in *Ptolomies* account, but 11. onely according to *Alfraganus*. Among which the bright one that is in his mouth, is called *Phom Ahut*, that is to ſay, the mouth of the Fiſh, and commonly by corruption, *Fomahant*.

There is alſo deſcribed in the Cœleſtiall Globe a certaine broad Zone or circle, of the colour of milke, which repreſenteth that which appeareth in the Heavens, and is commonly called *Via Lactea*, the milky way. Which Zone or circle is not drawne regularly or equally, either in reſpect of latitude, colour, or frequency of Stars; but is different and various both in forme and ſituation, in ſome places appeareing but as a ſingle circle, and againe in others ſeeming as it were dividing in two parts. The delination whereof you may ſee in the Globe, and the deſcription more largely ſet downe by *Ptolomy* in his *Almageſt*, *lib.* 8. *cap.* 2.

PONT. *This part of the Heavens hath in it* 7. *Stars of the firſt Magnitude, whereof the firſt is in the right ſhoulder of* Orion: *the ſecond, in his left foote: the third, in the end of the River* Eridanus; *the fourth, in the mouth of the great Dog, which they call* Sirius: *the fift, in the thigh of the Little Dog, called* Procyon: *the ſixth, is* Canobus, *in the ſhip* Argo: *and the ſeventh, is in the right foote of the* Centaure. *To which we may adde of the ſecond magnitude,* 18. *of the third,* 60. *of the fourth* 168. *of the fift,* 53. *of the ſixth,* 9. *and one cloudy one. All which are in the generall,* 316.

Now

Now the whole Firmament, reckoning in the Northerne and Southerne Hemiſphæres, together with the Zodiaque, containeth in all 1022. *Stars, which make up* 48. *Aſteriſmes or Conſtellations. Neither did either* Ptolomy, *or* Hipparchus *before him know any more then theſe. Notwithſtanding* Pliny, *as our Author hath advertiſed before in the ſecond Chapter, made the number of Stars and Conſtellations a great deale larger. But of this we ſhall ſpeake more in the end of the next Chapter. And concerning thoſe Conſtellations, which have beene more lately obſerved about the South Pole by the* Portugals *and* Hollanders, *and by them named, we intend to ſpeake ſomething in the end of the Chapter following.*

Chap. VII.

Of the Starres which are not expreſſed in the Globe.

BEſides theſe Stars which we have here reckoned up out of *Ptolomy*, there are yet many other to bee ſeene ſometime, eſpecially in the winter time, in a cleare night, when as there are both many more Stars to be ſeene, then at other times, and thoſe that are ſeene, appeare by much greater. Now if you expect that we ſhould aſſigne the cauſe of this: we might anſwer, that it is beſides the intention of our preſent purpoſe. Yet for your ſatisfaction, and becauſe that ſome Authors have very much

much erred from the right, in ſetting downe the true reaſon of the ſame: we doe therefore the more willingly make this digreſſion. For ſome there are, who (out of the extraordinary knowledge they have in Philoſophy, and Optickes) would very willingly perſwade us, that either we conceive them to be more, then indeed they are, and that our ſenſe onely is deceived: or elſe (which is altogether as ridiculous) that the ayre being in winter more pure and thin, maketh them more conſpicuous, which otherwiſe in the Summer, when the ayre is more groſſe, doe altogether lye hid. And this is an error which I doe not ſo much blame in others, as I wonder at it in *Johannes de Benedictis*: that ſo great a Mathematician, as he is held to be, ſhould be led away with ſo groſſe an error. For the reaſon of this is altogether otherwiſe and cleane contrary. For, for that very cauſe that the ayre is more groſſe and thicke, the Stars therefore doe appeare more, and greater. Which opinion of ours is confirmed, both out of principles of the Optickes, and alſo by the ſenſe of it ſelfe, experience, and authority of learned writers.

For firſt, that the raies being refracted through a groſſe *Medium*, and diffuſed as it were into certaine Canales, doe repreſent the image of the object greater then indeed it is, is plainely affirmed (and that according to the doctrine of the Optickes) by *Strabo* himſelfe out of *Poſidonius*. And that through *Perſpi-*

cills

oills or Spectacles, things appeare more, and greater then otherwiſe they would, is a thing well knowne to the moſt Ignorant. *Cleomedes* alſo ſaith, that the Sunne being ſeene by any in the bottome of a deepe Well, ſeemes greater, then when he is ſeene from above: and that by reaſon of the moyſtnes and groſſeneſſe of the ayre in the bottome of the Well. And if it were poſſible to ſee the Sunne through ſtone walles, or other ſolid bodies (as the old Poets fabulouſly report of *Lynceus*:) he would ſeeme much bigger then he is; as *Poſidonius* rightly teacheth. And hence is it, (ſaith *Strabo*) that we ſee the Sunne alwayes greater, at his riſing and ſetting, eſpecially to thoſe that are at Sea. Yet we doe not ſay that he appeares ten times greater then he is, as it is reported he doth in *India*, out of the Excerpts of *Eteſias* his Indian Hiſtories: much leſſe that he ſeemes to be an hundred times greater then he is in other places, as he is feighned by *Artemidorus* to be at his ſetting, to thoſe that inhabit a Promontory in the outmoſt parts of *Spaine*, which he calls *Promontorium Sacrum*: but is juſtly taxed for the ſame by *Poſidonius*. *Alfraganus* would have the cauſe of this to be, for that the vapours which are exhaled out of the earth, and elevated into the ayre, and ſo interpoſed betwixt our ſight and the Sunne at his riſing or ſetting, doe make him appeare greater then he is. The ſame is the opinion of *Strabo* and *Cleomedes* alſo, out of *Poſidonius*: neither doth this

this differ much from the opinion of the beſt of our Opticall writers. But of this enough.

There are alſo obſerved many Stars in the Southerne parts of the world: which becauſe they could not be ſeene by our Artiſts in this parts of the world, we have therefore no certaine knowledge left us concerning the ſame. So in like manner, among thoſe which we have hitherto ſpoken of, many of them cannot be ſeene by thoſe that inhabit any whit neare the North Pole. But concerning thoſe Stars that appeare about the South Pole of the world, I will here ſet you downe a very admirable ſtory, which *Franciſcus Patricius Senenſis* relateth in the end of his *Nova Philoſopia*, out of the Navigations of *Americus Veſpuccius*. And it is thus. *Cœlum decentiſſimè exornatur, &c.* The Heavens (ſaith he, meaning about the Antarctique Pole) is variouſly adorned with diverſe Conſtellations, which cannot be ſeene here with us: among which I doe very well remember that I reckoned very neare twenty, which were as faire and bright as *Venus*, and *Iupiter* here with us. And a little after he ſaith. I was certaine therefore, that theſe Stars were of greater magnitude, then any man can conceive: and eſpecially three *Canobi*, which I ſaw, and obſerved; two whereof were very bright ones, but the third was ſomewhat obſcure, and nothing like the reſt.

And a little after he proceeds. But the Pole it ſelfe is encompaſſed about with three Stars,

Stars, which repreſent the figure of a right-angled Triangle: among which, that which is in the midſt, is in circumference, 9. gr. and a halfe: and when theſe riſe, there appeares on the left hand of them another bright *Canobus* of notable magnitude.

And a little after he ſaith. After theſe there follow three other very faire Stars, the middlemoſt of which hath in Diameter 12. degrees and an halfe: and in the midſt among theſe, there is ſeene another *Canobus*. After this there follow 6. other bright Stars, which excell all the other Stars in the eighth Sphære for brightneſſe: the middlemoſt of them, having 32. gr. in Diameter. Theſe Stars are accompanied by another great, but darker *Canobus*: all which Stars are obſerved in the Milky way.

To this he addeth out of *Corſalius* this that followeth. *Andreas Corſalius* alſo affirmeth, that there are two clouds, of a reaſonable brightneſſe, appearing neare the Pole; betwixt which there is a Star diſtant from the Pole, about 11. gr. over which, he ſaith, there is ſeene a very admirable figure of a Croſſe, ſtanding in the midſt of 5. Stars that compaſſe it about, with ſome certaine others that move round about with it, being diſtant from the Pole, about 30. degrees: which are of ſo great brightneſſe, as that no Signe in the Heavens may be compared with them.

And now that you have heard this ſo ſtrange and admirable relation of the Stars about the

Antarctique Pole, *Auditum admissi risum teneatis?* For *Vespuccius* hath here forged three *Canobi*, whereas *Ptolomy*, and all the Ancient Greekes never knew but one, and that is it which is placed in the sterne of the ship *Argo*. And here it is very well worth our noting, that *Patricius* (as farre as I am able to gather out of his writings) out of *Vespuccius* his ill expressed language, and by him worse understood, hath very excellently framed to himselfe a strange kinde of Star, that hath in apparent Diameter, 32. degrees: whereas the Diameter of the Sunne it selfe hardly attaineth to 32. minutes.

But those things which out of our owne certaine knowledge and experience in above a yeares voyage on Sea, in the yeares, 1591. and 1592. we have observed beyond the *Æquator*, and about the Southerne parts of the world, we will here set downe.

Now therefore there are but three Stars of the first magnitude that I could perceive, in all those parts, which are never seene here in *England*. All which notwithstanding *Ptolomy* saw, in *Alexandria* in *Egypt*. The first of these is that bright Star in the sterne of *Argo*, which they cal *Canobus*. The second is in the end of *Eridanus*. The third is in the right foote of the *Centaure*. To which if you will adde for a fourth, that which is fixed in the *Centaures* left knee, I shall not much stand against it. But other Stars of the first magnitude, then these which I have named, that part of the world

world cannot shew us. Neither is there to be found scarcely two or three at the most, of the second magnitude, but what *Ptolomy* had seene. And indeed there is no part of the whole Heavens, that hath so few Stars in it, and those of so small light, as this neare about the Antarctique Pole. We had a sight also of those Clouds *Andreas Corsalius* speakes of, the one of them being almost twice or thrice as big as the other, and in colour, something like the *Via Lactea*, and neither of them very farre distant from the Pole. Our Mariners use to call them *Magellanes Clouds*. And we saw also that strange and admirable Crosse which he talkes of, which the *Spaniards* call *Crusero*, and our Countrimen, the *Crusers*. And the Stars of which this Crosse consists, were not unknowne to *Ptolomy* also: for they are no other, then the brighter Stars which are in the *Centaures* feete. All which things I did the more diligently and oftener observe, for that I remembred that I had read in *Cardan* also, strange relations of the wonderfull magnitude of the Stars about the South Pole; not unlike the stories we have now alleadged out of *Patricius*.

PONT. *The names of the Constellations of the Southerne Hemisphere as they have beene now lately observed, and named by the* Portugals *and others, are these. The* South Triangle; *the* Crane; *the* Pheenix; *the* Water Serpent; *the* Dorado, *or* Gilthead fish, *situated in the very Pole of the Ecliptique*; *the* Chamæleon

with the flie; *the* Flying Fiſh; *the* Bird of Paradiſe; *the* Peacocke; *the* naked Indian; *the bird* Toucan, *or* Braſilian *Pye. All which are accurately portraited in the Globes ſet forth by* Hondius. *Among all theſe there are no Stars of the firſt magnitude, but of the* 2. *ſeven: of the* 3. *ſix: of the* 4. *thirty five: of the* 5. *fifty ſix: of the* 6. *eleven: with ſix unformed, and two cloudy Stars, beſides the two cloudes themſelves. Now the whole number of the Stars in this Southerne part, beſides the cloudy ones, is* 121. *which being added to* 1022. *the whole ſumme will be* 1143. *Of which,* 1022. *were reckoned before by our Author, out of* Ptolomy: *onely there is a ſcruple caſt in our way by thoſe words of* Pliny, *in his* lib. 2. cap 41. Patrocinatur vaſtitas cœli, &c. *And this opinion (ſaith he) is ſeconded alſo by the vaſtneſſe and immenſity of the Heavens. Which is diſtinguiſhed into* 72. *Signes, all which are the reſemblances either of living creatures, or other things, according as they have beene reduced into method and order by the skilfull in thoſe Artes. Among which Conſtellations. they have obſerved* 1600. *Stars, all which are notable either in their effects or magnitude. Where we ſee that he accounteth the whole number of the Stars to be* 1600 *whereas* Ptolomy *after him acknowledged onely* 1022. *So likewiſe he reckoneth the Signes or Aſteriſmes to be in all* 72. *which yet in* Hipparchus, Eudoxus, *and* Ptolomies *account, are but* 48.

Scaliger *in his Commentaries upon* Manilius *pag.* 67. *that he might untie this knot, reads thoſe wor-*

words of Plinie thus. Patrocinatur vaſtitas cœli, immenſa altitudine, diſcreta in duo de L. ſigna, &c. where for ſeventy two, hee would have it to be wanting two: which is 48. the juſt number reckoned by Ptolomy. But yet the ſame doubt ſtill remaines in the enſuing words, where he maketh the whole number of the Stars to be 1600.

I find alſo two other Signes added to the former Southerne Conſtellations, which are Noah's Dove, and the Phœnicoptet. The firſt of which containeth in it, 11 Starres: of which there are two in the backe of it of the ſecond magnitude, which they call the Good meſſengers, or bringers of good newes: and thoſe in the right wing are conſecrated to the Appeaſed Deity, and thoſe in the left, to the Retiring of the waters in the time of the Deluge.

The Phœnicopter we may call the Bittour. Of this bird, Martiall hath an Epigram, lib. 13.

Dat mihi penna rubens nomen, ſed lingua guloſis
Noſtra placet. Quid ſi garrula lingua foret?

The Spaniards call it Flamengo: and it is deſcribed with the wings ſpread abroad, and as it were ſtriking with his bill at the South Fiſh, in that part where he boweth himſelfe. This Aſteriſme conſiſteth of 13. Starres: of which, that of the ſecond magnitude in his head is called, the Phœnicopters Eye: and it hath two other Stars alſo of the ſame magnitude, one in his backe, and the other in his left wing. And thoſe two which are in the middle of his necke, Paulus

Merula in his first booke of his Cosmography, *calleth his Collar or Chaine.*

Lastly, wee are to take notice that the Indians *call the South Pole,* Dramasa: *for so* Pliny *testifieth in his* lib. 6. cap. 19. Australinum Polum Indi Dramasa vocant.



The

The third Part,

Chap. I.

Of the Geographicall deſcription of the Terreſtriall Globe; and the parts of the world yet knowne.

Dionyſius Afer in the beginning of his *Periegeſis*, ſaith, that the whole Earth may be ſaid to be, as it were, a certaine vaſt Iland, encompaſſed about on every ſide with the Ocean. The ſame was the opinion of *Homer* alſo before him, and of *Eratoſthenes* (whom *Dionyſius* is obſerved by *Euſtathius*, his Scholiaſt, to follow in many things) as is witneſſed by *Strabo*. The ſame is affirmed by *Mela* alſo after him. This vaſt Iland of the whole Earth they would have to be terminated on the North ſide, with the frozen Sea, which is called by *Dionyſius*, *Mare Saturninum*, and *Mortuum*: on the Eaſt, with the Eaſterne Sea, which is alſo called *Mare Sericum*: on the South, with the Red Sea, (which *Ptolomy* calleth the Indian Sea) and the *Æthyopian*; and on the Weſt, with the *Atlanticke* Ocean. Out of this Ocean alſo,

there are foure principall gulfes (as the Ancient Geographers conceived) which emboſomed themſelves into the maine land. Two of which derived their courſe out of the *Erythraean* or Red Sea, to wit, the *Perſian* and *Arabian* gulfes. From the Weſt, there is ſent out of the Atlanticke Ocean a vaſt gulfe, which is called the *Mediterranean* Sea. And out of the North, they would have the Scythian Ocean to ſend in the Caſpian Sea, which is ſhut in almoſt on every ſide, with high craggy rockes; from whence the ſtreames flow with ſuch violence, that when they are come to the very fall, they caſt forth their water ſo farre into the Sea, without ſo much as once touching upon the ſhore, that the ground is left dry and paſſeable for whole Armies under the bankes: the ſtreames in the meane time being carried over their heads; as it is reported by *Eudoxus* in *Strabo*. This Sea both *Strabo*, *Pliny*, *Mela*, and *Solinus*, will have to come out of the Scythian Ocean, (as we have ſaid) But this errour of theirs beſides the experience of theſe later times, is manifeſtly convinced by this one teſtimony of Antiquity; which is, that the water of this Sea is found to be freſh and ſweet, as was firſt obſerved by *Alexander* the Great, and afterwards by *Pompey*, as M. *Varro* in *Solinus* teſtifieth, who at that time himſelfe ſerved under *Pompey* in his Warres. And this is the chiefeſt reaſon which *Polycletus* in *Strabo* alleadged, for the proofe of the ſame.

Now all this tract of land the Ancients divided

vided at first into two parts onely, namely, *Asia*, and *Europe*; to which, succeeding times added a third, which they called *Africa*, and sometimes also *Lybia*. And of these *Asia* is the greatest, *Africa* the next, but *Europe* the least of all: according as *Ptolomy* determines it, in the 7. booke of his Geography.

Europe is divided on the East from *Asia* by the *Ægæan* Sea (which is now called the *Archipelago*) and the Euxine Sea; which was at first (as *Strato* in *Strabo* thought) encompassed about on all sides in manner of a great lake, till at last by the great accession of other Rivers and waters, it so farre encreased, as that the bankes being unable to containe it, it violently made it's way into the *Propontis* and the *Hellespont*. The Euxine Sea is now called *Mare Maggiore*. It is also bounded on the same side, by the lake of *Mæotis* (now called *Mare delle zabacche*) the river *Tanais*, (commonly called *Don*) and the Meridian, which extends it selfe from thence to the Scythian or Frozen Sea. On all other sides it is encompassed with the Sea. For toward the South it is divided from *Africa* by the Straits of *Gibraltar*, and part of the Mediterranean Sea. (The length of these Straits is according to *Strabo*, and *Pliny*, 120. furlongs: and the breadth of it, according to the same *Strabo*, 70. furlongs. But *Mela* would have it to be 10. miles, that is to say, 80. furlongs. T. *Livius*, and *Cornelius Nepos* make the latitude of it to be, in the broadest place,

place, 10. miles, or 80. furlongs; and where it is narrowest, 7. miles, or 56. furlongs. But *Turannius Graccula*, who as *Pliny* reports, was borne about those parts, accounted it to be from *Mellaria*, a Towne in *Spaine*, unto that Promontory in *Africa*, which is called *Promontorium Album*, but 5. miles in all, that is, 40. furlongs. *Eratosthenes* was of opinion, that *Europe* was sometime joyned to the Continent of *Africa*. And it is reported by *Pliny*, that the inhabitants of those parts have a Tradition, that the *Isthmus*, or necke of the land by which *Europe* and *Africa* were joyned together, was cut through by *Hercules*.

Europe is terminated on the West with the Atlanticke Ocean; and on the North with the British, Germane, and frozen Seas.

PONT. *This Northerne part of Europe began first to be discovered and knowne to the world, in the raigne, or rather through the meanes, and by the direction of* Augustus Cæsar. *For as* Pliny *saith*, lib. 2. cap. 76. Septentrionalis Oceanus majore ex parte navigatus est, &c. *The Northerne Ocean for the greatest part was first searched by* Augustus Cæsar, *who sent forth a Navy, which passing all along the Coasts of Germany, came so farre as the Promontory of the Cimbrians, and thence passing on through a vast Sea, which they had onely heard of before, they went as far as the Coasts of* Scythia. *In which place* Pliny *meaneth those Sea expeditions, performed by* Tiberius, *and* Drusus Germanicus: *but especially that of* Drusus, *as may appeare by those words*

words of Tacitus, where he ſaith thus. Ipſum quinetiam Oceanum illa tentavimus, &c. *We left not the Ocean unattempted that way alſo, and it is a common fame, that* Hercules *Pillars are yet remaining; whether it be true indeed, that* Hercules *ever went ſo farre; or elſe that what ever Magnificent thing is any where to be found, we all conſpire unanimouſly to honour him therewith. Neither was there wanting courage for the attempt to* Druſus Germanicus: *onely the Ocean would not ſuffer it ſelfe, nor* Hercules, *to be farther enquired into. After this no man attempted it: and it was thought a greater point of reverence and religion, to believe the Actions of the gods, then to know them. Thus he.*

Now before this time, all this tract of land lying toward the North, the Romans called Novus Orbis, Ignotus Orbis, *the New and unknowne world: as I remember I have ſeene it, in a certaine Elegy of* Albinovus *upon the death of the ſame* Druſus. *And the Promontory of the Cimbrians, which* Pliny *ſpeakes of, is now called* Scagen, *and is the moſt northerne point of Denmarke.*

And as concerning theſe Pillars of Hercules, *mentioned by* Tacitus; Hadrianus Iunius *who ſometime ſaw theſe coaſts, referreth the ſame to that high rocke or Promontory in* Scandinavia (Iunius *hath it* Noruegia, *but not rightly*) *which is at this day called* Col, *both by the Natives, and our Mariners alſo. For in this place they have a ſuperſtitious cuſtome, that, as* Strabo *reports of the Gaditane Pillars, when any ſhippe had arrived there, as if they had attained an*

end

end of their labours and travaile, they forthwith sacrificed to Hercules : *in like manner in this place they have a custome, that if they have freshmen that never sailed those Northerne Seas before, they have certaine Ceremonies with which they use to make them free of the Seas, (as I my selfe once saw done sailing by this Promontory) for they take and bind them to the mast of the shippe, and then taking the scoope and filling it with Sea water, they make as it were a Libation, powring it upon their heads, which done, they are forthwith expiated, and accounted free of the place. But whereas* Iunius *would have the word* Col, *to be onely corrupted from* Columna, *I much doubt whether he will have any more of his opinion. But of this place, as also of all this Northerne tract of land, I shall have a more convenient opportunity to speake elsewhere.*

Africa is divided from *Asia*, according to *Dionysius* and *Mela*) by the river *Nilus*, and a Meridian drawne through it, to the Æthiopian Ocean. But *Ptolomy* would rather have its limits on this part to be the Arabian gulfe (which he not so rightly calleth, the Red Sea, and a Meridian, which should be drawne from thence to the Mediterranean Sea, over that necke of land which lyeth betwixt the two Seas, and which joyneth Ægypt to the Continent of *Arabia* and *Iudea*. Neither doth he thinke it congruous, that Ægypt should be divided into two parts, one whereof should be reckoned to Africke, and the other to Asia : which must needs be, if the river Nilus be set for

for the bounds of the ſame. Neither doth *Strabo* conceive this to be any whit improper, ſince that the length of this *Iſthmus*, which divideth the two Seas, is not above 1000. furlongs. And he ſeemeth to have ſaid very rightly, that it is not above a 1000. furlongs. For however *Poſidonius* reckoneth it to be very neere 1500. furlongs: yet *Pliny* would have it to be no more then 115. miles, that is to ſay, 920. furlongs. And *Strabo* alſo reckoneth the diſtance betwixt *Peluſium* and the *Heroes* City, which is ſituate cloſe by the higheſt part of the Arabian Gulfe, to be but 900. furlongs. But if we will give any credit to *Plutarch*, at the narroweſt part of the *Iſthmus*, the two Seas will be found to be diſtant not above 300. furlongs. And that, (when *Anthony* was overthrowne by *Auguſtus* in a Sea fight, and all his forces cleane broken,) *Cleopatra*, ſeeking to avoid the ſervitude of the Romans, went about to tranſport her navie this way over the firme land, that ſo ſhe might find ſome new place of habitation, as farre remote from the Romans as ſhe might: as it is reported by the ſame Author, in the life of *Anthony*. But what ſhould move *Copernicus*, in his 1. *booke* 3. *Chap.* to ſay, that theſe two Seas are ſcarcely 15. furlongs diſtant; I cannot conjecture; unleſſe I ſhould thinke the place to be corrupted, through the negligence of the Tranſcribers, or Printers. And yet I could wiſh, that this, (though it be a very great one,) were all the errours that were to bee found in the writ-

ings

ings of that moſt excellent man.

This *Iſthmus*, as *Eratoſthenes* conceived, was anciently covered all over with waters, till ſuch time as the Atlanticke Ocean had intercourſe with the Mediterranean: And ſome of the old Grammarians, Scoliaſts on *Homer*, doe affirme, (as *Strabo* teſtifieth) that it was this way, that *Menelaus* in *Homer*, ſailed to the *Æthyopians*. I will therefore here ſet downe ſome few things, which may ſeeme to make for the confirmation of this relation, (whether you will call it an Hiſtory, or rather a Fable, or Conjecture) of *Eratoſthenes*.

Firſt therefore that *Egypt*, (if not all of it, yet at leaſt that part of it, which is ſituated beneath *Delta*, and is called *Egyptus Inferior*, the lower *Egypt*, and is accounted to be the gift of *Nilus* (or rather of the Sea) was made by the aggeſtion and gathering together of mud and ſand; was the conjecture of *Herodotus*, long before *Strabo*. In like manner, that the Iland *Pharos*, which in *Plinies* time was joyned to *Alexandria* by a bridge, as himſelfe teſtifieth, lib. 5. cap. 31. (and therefore for this reaſon may ſeeme to have beene called a Peninſula by *Strabo*) was anciently diſtant from *Egypt* a whole day and nights ſaile, is reported both by *Pliny* and *Solinus*, out of *Homer*. And this is the reaſon, as *Strabo* conjectures, that *Homer*, (whereas he makes often mention of *Thebes* in *Egypt*) yet ſpeakes not one word of *Memphis*: and that either becauſe at that time it was a very ſmall place,

or

or elſe perhaps was not as yet in being, the land being in *Homers* time covered all over with water, where *Memphis* was afterward built. And this ſeemes alſo to be confirmed by the great depreſſion and lowneſſe of the intermediate ſhore betwixt the two Seas; which is ſo great, that when *Seſoſtris* firſt had an intent of cutting a channell betwixt the two Seas, as was afterward intended alſo by *Darius*, and laſtly, by *Ptolomy*; they were all forced for this reaſon to deſiſt from their enterpriſe. And indeed *Strabo* reports, that himſelfe ſaw the *Egyptian* ſhore in his time all overflowed, beyond the Mountaine *Caſius*. Beſides, the great retireing of the waters at an ebbe, as well in the Arabian gulfe, as in the Perſian, ſeeme ſomewhat to confirme this conjecture of *Eratoſthenes*. For the tides withdraw themſelves ſo farre backe in the Arabian gulfe: that *Iulius Scaliger* makes mention of ſome Cavillers, that for this very reaſon went about to derogate from the miraculous paſſage of the Children of *Iſrael* for the ſpace of above 600. miles through the red Sea: as if they had watched their time, when the tide gave way: and that when it returned againe, the *Egyptians* were overtaken therewith and all drowned.

PONT. *This Sea is alwayes rendred by the Septuagint*, Erythræum; *and by St.* Hierom, Rubrum: *but the Hebrew text it ſelfe, underſtanding this gulfe of the Sea (which is called alſo by* Ptolomy, Sinus Arabicus) *calleth it* Mare Suph;

Suph; *which is as much as to ſay,* Mare algoſum, ſeu caricoſum, *becauſe it bringeth forth great ſtore of* Alga, *and Sea Weedes. Which is obſerved alſo by* Pliny, *lib.* 13. *cap.* 25. *where he ſaith.* Naſcuntur & in mari frutices, &c. *There are alſo bred ſhrubs in the Sea: and in our Sea, little trees alſo. For the Red Sea, and all the Eaſterne Ocean is full of trees. For no other language hath a proper word to expreſſe that which the Greekes call* φύκος *becauſe that* Alga *is more uſually taken for the name of an hearbe, but in this place it ſignifieth a ſhrub. Thus* Pliny. *You may alſo ſee* Strabo, *lib.* 16. *That place which the Author citeth out of* Scaliger, *is in his* 35. *Exercitation againſt* Cardan. *And I thinke it not amiſſe to heare him ſpeaking in his owne words, that ſo it may appeare what his judgement is of that which is objected by thoſe Cavillers. His words are theſe.* In plaga Indica ſecundùm Gangis atque Indi fauces magnus eſt æſtus, &c. *About the coaſts of India (ſaith he) where the Rivers* Ganges *and* Indus *disburthen themſelves into the Sea, there are very high tides: So likewiſe in the Red Sea they are ſo great, as that the contemners of Holy Writ have impiouſly forged, that Moſes, when he led the Iſraelites out of Egypt, tooke the opportunity of the waters retiring after the tide. Which notwithſtanding could not poſſible be, becauſe that as farre as* Sues, *which is ſituated in the innermoſt corner of the gulfe, the Sea covereth the very ſhore; neither, when it ebbeth, doth it ever leave the ground ſo bare, as that the lower parts, through which the*

Iſraelites

Iſraelites *paſſed, ſhould be free from paſſage on foote.*

And it is reported by *Pliny*, that *Numenius*, Generall to *Antiochus*; fighting againſt the Perſians, neare the mouth of the Perſian gulfe, not farre from the Promontory called *Macavum*, got the victory of them twice in one day, firſt by a Sea combat; and afterward (the waters having left the place dry) on horſbacke: as it is related by him in his 6. booke, 28. cap.

And thus much concerning *Eratoſthenes* his conjecture. Let us now returne to the bounds of *Africa*. Which is divided (as we have already ſaid) on the Eaſt from *Aſia*, by a Meridian drawne through the Arabian gulfe to the Mediterranean Sea. On all other ſides it is encompaſſed about with the Sea: as on the Weſt, with the Alanticke; on the South with the *Æthiopian* Ocean: and on the North, by the Mediterranean, which is alſo the Southerne bound of *Europe*.

Now as concerning *Ptolomies* ignorance of the Southerne parts of *Africa*, making it a continent and contiguous to *Aſia* by a certaine unknowne land, which he would have to encompaſſe about the South ſide of the *Indian* Sea and the *Æthiopian* gulfe: if it be not ſufficiently evinced out of the relations of the Ancients; as namely, of *Herodotus*, who reporteth, that certaine men were ſent forth by *Darius* by Sea, who ſailed about all this tract; nor yet of *Heraclides Ponticus*, who relates a

story of a certaine Magician that came from *Gelon*, who said that he had compassed about all these coasts: (because *Posidonius* accounteth not these relations of credit enough to conclude any thing against *Polybius*: neither doth he approve of that story of one *Eudoxus Cyzicenus*, reported by *Strabo*, *Pliny*, and *Mela*, out of *Cornelius Nepos*, an Author of very good esteeme, (and that because *Strabo* thought this relation to deserve no more credit, then those fabulous narrations of *Pytheas*, *Evemerus*, and *Antiphanes*:) nor lastly, those traditions of King *Juba* concerning the same matter, related by *Solinus*: Howsoever, I say, that these Traditions of the Ancients doe not convince *Ptolomy* of ignorance; yet certainely the late navigations of the Portugals most evidently demonstrate the same, who touching upon the outmost point of all *Africa*, which they now call, the *Cape of good hope*, passe on as farre as the East Indies. I shall not in the meane time neede to speake at all of that other story wch *Pliny* hath: how that at what time *C. Cæsar*, Sonne to *Augustus*, was Proconsul in Arabia, there were certaine Ensignes found in the Arabian gulfe, which were knowne to be some of those, that were cast away in a shipwracke of the Spanish Nauy: and that *Carthage* at that time being in her height of power, *Hanno* a Carthaginian sailed about from *Gades*, as farre as *Arabia*, who also afterward himselfe wrote the story of that navigation.

Asia

Aſia lyeth Eaſtward both from *Europe* and *Africa*, and is divided from them, by theſe bounds and limits which we have already ſet downe. On all other parts it is kept in by the Ocean: on the North, by the *Hyperborean* or Frozen Sea: on the Eaſt, by the *Tartarian* and Eaſterne Ocean: on the South, by the Indian and Red Sea. But *Ptolomy* would have the Northerne parts of *Aſia*, as alſo of *Europe*, to be encompaſſed, not with any Sea, but with a certaine unknowne land: which is ſtill the opinion of ſome of our later writers, who thinke that Countrey, which we call *Groenland*, to be a part of the Indian Continent. But we have very good reaſon to ſuſpect the truth of this their opinion; ſince that ſo many Sea-voyages of our owne country-men, who have gone farre within the Arcticke circle, beyond the utmoſt parts of *Norway*, and into that cold frozen channell, that divides *Nova Zemla* from *Ruſſia*: doe ſufficiently teſtifie, that all thoſe parts are encompaſſed with the Sea. Not to ſpeake any thing of that which *Mela* alleadgeth out of *Cornelius Nepos*, how that when *Q. Metellus Celer* was Proconſul in *Gallia*, there were preſented him by the King of *Suevia*, certaine Indians, who having beene ſevered by force of tempeſts from the Indian ſhore, had beene brought about by the violence of the windes as farre as *Germany*. Neither will I here mention that other relation of *Patrocles*, in *Strabo*: who affirmed, that it was poſſible to

ſaile to India, all along the Sea ſhore a great deale more Northward then the *Bactrians*, *Hircania*, and the *Caſpian* Sea: now *Patrocles* was made governour of theſe places. Nor laſtly, that which *Pliny* himſelfe reporteth, how that all this Eaſterne coaſt, from India as farre as to the *Caſpian* Sea, was ſailed through by the Macedonian Armies, in the raigne of *Seleuchus* and *Antiochus*.

Concerning the quantity of the Earth which was inhabited, there was great diverſity of opinions among the Ancient. *Ptolomy* defined the longitude of it to be, from Weſt to Eaſt, beginning at the Meridian which paſſeth through the fortunate Ilands, and ending at that which is drawne through the Metropolis of the *Sinæ*, or Chineans countrey. So that it ſhould containe halfe the Æquator, which is 180. degrees, and 12. Æquinoctiall houres, or 90000. furlongs meaſured by the Æquator. And he determined the bounds of the latitude to be, toward the South, that Parallel which lyeth 16.gr. 25. m. Southward of the Æquator: and the Northerne limits he made that Parallel, which paſſeth through *Thule* or Iſeland, being diſtant from the Æquinoctiall 63. degrees. So that the whole latitude of it contained in all, 79. gr. 25. m. or 80. whole degrees, which is neare upon 40000. furlongs. The extent of it therefore from Eaſt to Weſt, is longer, then it is from North to South, under the Æquinoctiall ſomthing then more by halfe as much, and under the

the moſt Northerne Parallel, almoſt by a fiftieth part. Good reaſon therfore had the Ancient Geographers, as *Ptolomy* conceives in his *lib. 1. cap. 6. Geograph.* to call the extent of it from Weſt to Eaſt, the Longitude of it; and from North to South, the Latitude. *Strabo* alſo acknowledgeth the Latitude, with *Ptolomy*, to be 180. degrees in the Æquator, as likewiſe *Hipparchus* doth alſo: notwithſtanding there is ſome difference betwixt them, in the number of the furlongs. For theſe laſt have ſet downe the Longitude to be of 126000. furlongs under the Æquator: herein following *Eratoſthenes*, who reckoneth 700. furlongs to a degree. But *Strabo* maketh the Latitude a great deale leſſe; that is, ſomething leſſe then 30000. furlongs: and hee boundeth it on the South, with the Parallel drawne through *Cinnamomifera*, which is diſtant Northward from the Æquator 8800. furlongs: and on the North with that Parallel, which paſſeth through thoſe parts which are 4000. furlongs, or thereabout, more Northward then *Britaine*. And this Parallel that paſſeth through the Region called *Cinnamomifera*, *Strabo* makes to be more Southward then *Taprobane*, or at leaſt to paſſe through the moſt Southerne parts of the ſame. But herein he betrayeth his own notable ignorance: for as much as the moſt Southerne part of this Iſland is extended farre beyond the Æquator; as both *Ptolomy* affirmeth in his *Geography*, *lib. 7. cap. 4.* and is further confirmed by the late Navigations of the *Portu-*

gals. But *Dionyſius Afer* is much farther out of the way then ſo: for he placeth *Taprobane* under the Tropicke of *Cancer*.

And theſe were the bounds wherewith the Ancient Geographers terminated the then inhabited parts of the world. But in theſe riper times of ours, by the induſtry at Sea, both of the Spaniards, Engliſh, and others, the Maritime coaſts of Africa have beene more throughly diſcovered, to above 35. gr. of Southerne Latitude: and the Northerne limits of Europe have now beene ſearched into, as farre as the 73. degree of Northerne Latitude, farre within the Arcticke circle: beſides all that which hath at length beene diſcovered in the New world, beyond the hope or opinion of any of the Ancients, the name of it being not ſo much as knowne to them.

America, which for it's ſpaciouſneſſe may well be called, The other world, extending it ſelfe beyond 52. gr. of Southerne Latitude, is there bounded with the Straits of Magellane: and toward the North it runneth farre within the Arcticke circle: on which ſide alſo that it is bounded by the Sea, the many Navigations of our Country-men into thoſe parts, doe give ſtrong arguments of hope. I ſhal not here ſpeak of thoſe Sea coaſts, which are beyond that Sea that encompaſſeth about the moſt Northerne parts of Europe and Aſia; as having been but only ſeene afarre off as yet, and not throughly diſcovered. Nor yet thoſe other, which are more Southerne then the Indian and Red

Seas:

Seas: which as yet we have not any experience to the contrary, but that wee may beleeve to bee one continent with thoſe other Southerne Lands, that lye beyond the Straits of Magellane.

Europe (whether ſo called from *Europa Tyria*, daughter to *Agenor*, as ſome thinke; or *Phœnix*, as *Herodotus* will have it; or elſe from *Europa* a Sea Nymph, according to the opinion of *Hippias* in *Euſtathius*; or elſe from *Europus*, as *Nicias* in the ſame *Euſtathius* would have it to be;) containeth in it theſe principall regions: to wit, Spaine, France, Italy, Germany, Bohemia, Pruſſia, Rhætia, Livonia, Sclavonia, Greece, Hungary, Polonia, Moſcovia or Ruſſia, Norway, Sweden, and Denmarke. To theſe wee may adde the principall Iſlands, as namely thoſe of great Britaine, the chiefe of which is England, and Scotland, ennobled chiefely by being united to the Engliſh Crowne: as alſo Ireland, which is in like manner ſubject to the ſame. Beſides the Azores, and many other Iſlands ſcattered up and downe in the *Mediterranean* Sea, as Sicily, Sardinia, Crete, *&c.*

NOTE. *In Europe theſe things are chiefely obſervable.* 1. *The moſt famous Monarchies which are in it; as namely the Emperour of Germany, the Kings of Spaine, France, Great Britaine, Denmarke, Swethland, Polonia, and Moſcovia. To which we may adde the Pope of Rome, who though he uſurpe not the title of a King, yet is his power no whit inferiour to theirs: as alſo the great*

Turke, who at this day possesseth a great part of Europe also. 2. *The principall hilles, which are the* Alpes *dividing Italy from Germany and France; and also the Pyrenæan Hilles, severing Spaine from France.* 3. *The notable rivers, as the Danow, the Rheine, the Elue, the Weisell, Boristhenes, and Tanais, now called Don. To which we may adde the river Tagus in Spaine, the Rh ne and Guaronne in France, and Thames in England. Lastly, the principall commodities in Europe, are Gold, Silver, Tinne, Lead, Iron, Oyle, all kind of graine, Flaxe, Wooll, Salt,* &c.

Africa (whether it be so called from *Apher*, one of *Hercules* his companions, in his expedition against *Gerion*; according to *Eustathius:* or else from one *Iphricus*, a certaine King of the *Arabians*; whence also it is called in Arabicke *Iphricia*, as *Iohannes Leo* testifieth: or lastly from its scorching heat, as if it should bee called ἀφρικὴ *quasi sine frigore*, as some are pleased to derive it:) hath in it these principall regions. First of all next to the Straits of Gibraltar, (anciently called *Fretum Gaditanum*) there lyeth *Barbary*, heretofore called *Mauritania*; which containeth in it the kingdomes of *Morocco, Fez, Algier*, and *Tunis*. Next to *Barbary* lyeth *Ægypt*, which also bordereth upon the *Mediterranean* Sea. Now within *Barbary* toward the continent, there lyeth *Biledulgerid*, known to the Ancients by the name of *Numidia*. The 3^d^ is that part which is called by the Greekes and Latines *Libya*: but the *Arabians* name it Sarra. After this followes the countrey

trey of the *Negroes*, so called because they border upon the River *Niger*, or else from their colour. This Country is now usually called *Senaga*: and it hath in it many petty kingdomes, as namely, *Gualata*, *Guinea*, *Melli*, *Tombutum*, *Gagos*, *Guberis*, *Agades*, *Canos*, *Casena*, *Zegzega*, *Zanfaran*, *Burnum*, *Gaoga*, *Nubia*, *&c.* Next to these is the spacious Territory of the King of the *Æthiopians*, (who is also called *Pretegiani*, and corruptly *Prester Iohn*) which kingdome is famous for the long continuance of the Christian Religion in it, which hath been kept amongst them in a continuall succession, ever since the Apostles time. These Christians are commonly called *Abyssines*, but more rightly *Habassines*, as *Arias Montanus* observeth in the *Itinerary* of *Benjamin Tudelensis*. Their dominion was anciently extended very farre through *Asia* also. These have bordering on the West some few obscure kingdomes, as *Manicongo*, and *D' Angola*: and toward the East and South, *Melinde*, *Quiloa*, *Mozambique*, and *Benamatapa*. The chiefe Ilands that are situate neare it, are *Madagascar*, the Canary Ilands, the Isles of *Cape Verd*, and S. *Thomas Island*, lying directly under the *Æquator*.

PONT. Africa *hath these things in it considerable.* 1. *It is greater then* Europe, *but lesse then* Asia, *and lesse inhabited, and civilized then either.* 2. *It is bounded with the Sea on all sides, save only where it is conterminate with* Asia. 3. *The principall regions of it, are,* Mauritania, Numidia,

Numidia, Libya, Cyrenaica, Egypt, *and* Æthiopia. 4. *The most famous kingdomes are these,* Morocco, Fez, Algier, *and also that of* Prester Iohn, *or* Æthiopia. 5. *The greatest Mountaines are,* Atlas, *and that other whence* Nilus *springeth.* 6. *The principall rivers are* Niger, *and* Nilus, *which is accounted to be the greatest in the world, and as* Diodorus Siculus *affirmeth, encompasseth* 700. *Islands.* 7. *The principall Merchandise of* Africke, *is Ivory, Civet, Gold, Cotton Wooll, Iewels, and certaine kinds of spices, as also Salt, Lions, Camels,* &c.

Asia (so called from *Asia*, the mother of *Prometheus*, as the common received opinion is; or else from a certaine Hero of that name, as *Hippias* in *Eustathius* wil have it, at this day wholly in subjection to the great Turke, and the *Persian*, as farre as to the East Indies, the greatest part whereof is under the Kings of *China* and *Pegu*. But the more Northerne parts of *Asia* are possessed by the *Muscovites*, *Tartarians*, and those that inhabit the region of *Cathaia*. The principall Islands appertaining unto it, are *Cyprus*, and *Rhodes* in the *Mediterranean:* and on the South side, *Sumatra*, *Zeilam*, *Iava Major* and *Minor*, the *Molucean* and *Philippine* Islands, beside *Borneo*, and almost an infinite company of others. And on the East of it there lye the *Japonian* Islands.

Pont. *That it ought to be written* Sinæ, *not* Chinæ, *as our Auther in this place, and commonly all other writers use to doe, appeareth manifestly out of* Ptolomy, *who alwayes calleth them*

them Sinæ. The eight Table alſo of Aſia in Ptolomyes Geography, placeth the Scythians called Cathæ, (which our Author calleth the region of Cathaia,) betwixt the mountaines Imavus and Emodus: and the region of the Sinæans a part of it beyond the ſame Emodus and Ottoro cara, which are hills in the Countrey of the Seres, and looking towards the Southeaſt. So that I cannot but wonder that Matthæus Riccius a Ieſuite, in his Sinæan expedition ſhould take ſo much paines to prove, that the Kingdome of Cathaia, and of the Sinæans is all one. But it were eaſie, by other and thoſe more proper arguments, and teſtimonies, (were this place convenient) to prove the contrary to this his aſſertion.

Now as concerning Aſia, theſe things occurre in it worth our obſervation. 1. That it is twofold, Aſia Minor, and Major. 2. Aſia Minor, or the leſſer Aſia, is bounded on the Eaſt by the Euxine Sea; on the South by the river Euphrates; on the Weſt by the Mediterranean, on the North by the Ægean Sea. 3. The principall countries it contained anciently, were theſe: Cilicia, Pamphilia, Caria, Lycia, Ionia, Lydia, Æolia, Myſia, Bithynia, Paphlagonia, Cappadocia, Galatia, Lycaonia, and Piſidia. 4. To the greater Aſia theſe regions appertained: Syria, Armenia, Chaldæa, Arabia, Perſia, Tartaria, Hircania, Parthia, and India. 5. In both of them there are ſetled at this day theſe Empires; namely, the Turkiſh, Perſian, Tartarian, Indian, and Sinenſian or Chinean. 6. The chiefe hills of note in it, are Taurus, Caucaſus, and Imaus. 7. The principall

principall rivers, Euphrates Ganges, *and* Indus. 8. *Their chiefeſt trafficke is, Gold, Pearle, Iewells, all kinde of Spices, Muske, Frankincenſe, Balſame, Amber, Silkes, Ivory, and Elephants.*

America, (ſo called from *Americus Veſpuceius*, who firſt diſcovering it, gave it both name and bounds,) is terminated on the Eaſt ſide, (on which it lookes toward *Europe* and *Africa*) by the *Atlanticke* Ocean: on the Weſt with the Sea which they call, *del Zur*, or the South Sea: on the South it is bounded with the Straits of *Magellane*. But as for the Northerne parts of it, they are not yet thoroughly diſcovered, or the limits thereof knowne: notwithſtanding the many adventures by Sea of our Countreymen, Mr. *Martin Frobiſher*, and Mr. *John Davis*, have given ſtrong arguments of hope, that it is on that ſide bounded by the frozen Sea. It containeth in it theſe principall regions. Firſt on the North, that countrey which the *Spaniards* call, *Tierra de Labrador*: after which followeth that which they call, *Baccalearum Regio*: then *Nova Francia*: after this *Virginia*; then *Florida*: next to this, *Nova Hiſpania*, famous eſpecially for the City *Mexico*, and laſt of all the Kingdomes of *Braſilia* and *Peru*, which are the moſt Southerne parts of all. There are alſo many adiacent Iſlands: moſt of which lye in the Bay of *Mexico*, eaſtward from *America*: the moſt notable of which are *Cuba*, and *Hiſpaniola*, beſides many other of leſſe note.

There

There are alſo many other parts of the world, not yet thoroughly knowne or diſcovered, as namely thoſe Southerne coaſts wherin ſtands *Nova Guinea* lying beyond the Indian Sea, which whether it be an Iſland, or elſe a part of the maine Continent, is not yet diſcovered: and likewiſe that other tract of the Southerne unknowne Continent, which is called *Magellanica*: as alſo thoſe Northerne parts of *Europe*, *Aſia*, and *America*, which have beene but lately detected by many of our Engliſh Navigatos, but not as yet fully ſearched into.

CHAP. II.

Of the Circumference of the Earth, or of a Greater Circle: and of the Meaſure of a Degree.

IT remaineth now that we ſpeake ſomewhat of the circumference of the Earth, or of the greateſt circle in it; the knowledge whereof is very neceſſary, both for the ſtudy of *Geography*, as alſo for the eaſier attaining to the Art of Navigation. And therefore, I hope, I ſhall not ſeeme impertinent, if I inſiſt ſomething the longer on this argument: eſpecially ſeeing that there is great diverſity of opinion among the moſt learned Authors that are extant, concerning this matter; in ſo much that it is not yet determined, which of them we are to follow.

Ariſtotle

Ariſtotle in the end of his 2d. booke *de Cœlo*, affirmes (and that according to the doctrine of the Mathematicians, as himſelfe ſaith) that the circumference of the Earth is 400000. furlongs. *Cleomedes lib.* 1. reckons it to be 300000. for he ſaith, that the Verticall Points of *Lyſimachia* and *Syene*, were obſerved by Scioterical Inſtruments, to be diſtant from each other the 15th part of the ſame *Meridian*. Now the diſtance betweene theſe two places hee ſets downe to bee 20000. furlongs: So that if 20000. bee multiplied by 15. the whole will ariſe to 300000. *Eratoſthenes* (if we may beleeve *Strabo*, *Vitruvius*, *Pliny*, and *Cenſorinus*) would have the whole compaſſe of the Earth to containe 252000. furlongs. To which number *Hipparchus*, as *Pliny* teſtifieth, added very neare 25000. more. Yet *Strabo* as well in the end of his 2d. booke of his Geography, as elſewhere, affirmeth, that he uſed the ſame meaſure that *Eratoſthenes* did: where he ſaith, that according to the opinion of *Hipparchus*, the whole quantity of the Earth containeth 252000. furlongs; which was the meaſure delivered alſo by *Eratoſthenes*. Which opinion of *Eratoſthenes* is ſeconded alſo by that fabulous relation of *Dionyſiodorus*, recorded by *Pliny*, *lib.* 2. *cap. ult.* where he ſaith, that there was found, in the Sepulchre of *Dionyſiodorus*, an Epiſtle written to the gods; wherein was teſtified, that the Semidiameter of the Earth contained 4200. furlongs. Which number being multiplied by 6. the Product will bee 252000.

Cleo-

Cleomedes relating the obſervations of *Eratoſthenes*, and *Poſidonius*, maketh it to be ſomewhat leſſe, and that according to the doctrine of *Eratoſthenes*: to wit, 250000. furlongs. For he placeth *Syene* and *Alexandria* under the ſame *Meridian*. Now *Syene* being ſituate directly under the Tropicke of *Cancer*, the Sun being then in the Summer Solſtice, the *Gnomons* caſt no ſhadow at all. For confirmation of which, the experiment was made, by digging a deepe Well, which at that time of the yeare was wholly enlightned on every part: as it is reported both by *Pliny*, and alſo by *Strabo* before him. But at *Alexandria*, when the Sunne is in the Summer Tropicke, the *Gnomon* is obſerved to caſt a ſhadow to the fiftieth part of the circumference, on which it is erected to right angles, ſo that the top of the ſame, is the center of the circumference. Now the diſtance betwixt *Syene* and *Alexandria* is commonly ſet downe by *Eratoſthenes*, *Pliny*, and *Strabo*, to be 5000. furlongs. If therefore 5000 be multiplied by 50. the whole will ariſe to 250000. which is the number of furlongs aſſigned to the circumference of the whole earth by *Eratoſthenes*. *Poſidonius*, proceeding after another method, though not unlike this, labours to prove the whole circuit of the Earth to containe 240000 furlongs. And firſt hee taketh for granted (which is alſo acknowledged by *Ptolomy*, *lib.* 5. *cap.* 3. *Almageſt.*) that *Rhodes* and *Alexandria* are ſituate under the ſame Meridian. Now that bright Star in the ſterne of *Argo*, (which they

they call *Canobus*, and which never appeareth in Greece, which ſeemes to be the reaſon why *Aratus* maketh no mention of it:) firſt beginneth to appeare above the Horizon at *Rhodes*: but it doth but *ſtringere Horizontem*, juſt touch the Horizon, and ſo upon the leaſt circumvolution of the heavens ſetteth againe: or elſe, as *Proclus* ſaith, is very hardly ſeene, unleſſe it be from ſome eminent place. But when you are at *Alexandria*, you may ſee it very cleare above the Horizon. For when it is in the *Meridian*, that is, at the higheſt elevation above the Horizon: it is elevated above the Horizon about the fourth part of a Signe: that is to ſay, the fortie eighth part of the *Meridian* that paſſeth through *Rhodes* and *Alexandria*. The ſame is affirmed alſo by *Proclus*, if you read him thus: *Canobum in Alexandria conſpicuè cerni, quarta circiter Signi portione ſupra Horizontem extante*: as it ought to be; and not as it is corruptly read, *in Alexandria prorſus non cerni*. It is not ſeene at all: in ſtead of, It is ſeene very plainely: ἀφανὴς being crept into the text, perhaps in ſtead of ἐυφανὴς. Now the diſtance betwixt *Rhodes* and *Alexandria* is ſet downe both by him, and *Pliny*, to bee 5000. furlongs: which being multiplied by forty eight, the product will be 240000. the number of furlongs agreeing to the meaſure of the Earths circumference, according to the opinion of *Poſidonius*.

Ptolomy every where in his *Geography*, as alſo *Marinus Tyrius* before him, have allowed but

but 500. furlongs to a degree in the greateſt circle on the earth, of which the whole circumference containeth 360. ſo that the whole compaſſe of the Earth, after this account, containeth but 180000. furlongs. And yet *Strabo* affirmes in his *lib.* 2. *Geograph.* that this meaſure of the Earths circumference ſet downe by *Ptolomy*, was both received by the Ancients, and alſo approved by *Poſidonius* himſelfe.

So great is the difference of opinions, concerning the compaſſe of the Earth: and yet is every one of theſe opinions grounded on the authority of great men. In this ſo great diverſity therefore, it is doubtfull whom we ſhould follow. And if you ſhould deſire to know the cauſe of all theſe diſſenſions; even that alſo is altogether as uncertaine. *Nonius*, and *Peucerus* would perſwade us, that certainly the furlongs they uſed were not of the ſame quantity. *Maurolycus*, and *Philander* conceive the difference of furlongs to riſe out of the diverſe meaſure of Paſes. And therefore *Maurolycus* takes great paines to reconcile them; but in vaine: for they ſeeme not capable of any reconcilement. They tell us of diverſe kinds of Paſes in uſe among the Ancients. It is true; wee aſſent to them herein: but withall deſire to heare of ſome diverſitie of furlongs alſo, or at leaſt, of feet. The Greekes (as I conceive) meaſured not their furlongs by Paſes; but by feet, or rather τὰις ὀργυιὰις. Now ὀργυὰ is the meaſure of the extenſion of both the hands, together with the breaſt betwixt, containing

ſixe feet, which we commonly call a fadome, and is a meaſure in familiar uſe with our Mariners, in founding the depth of the Sea, or other waters. This word notwithſtanding is tranſlated by many, a Paſe: but how rightly, I leave it to learned men to judge. *Xylander* in his tranſlation of *Strabo*, alwayes rendereth it, an Ell. In like manner a furlong is defined by *Herodotus*, a very ancient Greeke Author, to conſiſt of 600. feet: the ſame alſo is affirmed by, *Suidas*, by much later then hee. Yet *Hero Mechanicus* (or at the leaſt his Scholiaſt) one, as I conceive, of the loweſt ranke of Ancient Writers,) will have a furlong to containe 100. fadomes; a fadome foure Cubits: a Cubit a foot and a halfe, or twenty foure digits: But you will ſay perhaps, that *Cenſorinus* propoſeth three ſeverall kindes of furlongs: the firſt of which is the *Italian*, conſiſting of 625. feet: which he would have us underſtand to be that which is commonly uſed in meaſuring the Earth. The ſecond is the *Olympian*: containing 600. feet: and the third and laſt is the *Pythean*, conſiſting of 1000. feet. But to let paſſe this later, if wee doe but looke more nearely into the matter, we ſhall find the *Italian* and *Olympian* furlongs, howſoever they differ in names, yet to be no other but the ſelfe ſame thing. For the *Italian* furlong, which containeth 625. Romane feete, (according as *Pliny* teſtifieth, in his ſecond booke and twentie third Chapter) will bee found to be equall to the *Olympian*, conſiſting of 600. Grecian

feet

ſeete. For 600. Grecian feet, are equall to 625. Romane: for as much as the Grecian foote exceeds the Romane by a twenty fourth part: as much as is the difference betwixt 600. and 625.

Amongſt theſe ſo great diverſities of opinions, let us give our conjecture alſo, both what may be the cauſe of ſo great diſagreement; and alſo which of them we may moſt ſafely follow: We will therefore paſſe by *Ariſtotle*, whoſe aſſertion is only defended by a great name. And for *Cleomedes* his opinion, of the Earths being in compaſſe 200000. furlongs, we ſhould ſcarſe vouchſafe to mention it; but that *Archimedes* alſo had taken notice of the ſame, as of a po - tion not altogether diſallowed in his time. Let us therefore examine *Eratoſthenes*, and *Poſidonius*, whoſe opinions ſeeme to be grounded on more certaine foundations. The cauſe therefore of their diſagreement I conceive to bee, in that neither of them had meaſured exactly the diſtances of thoſe places which they layd downe to worke on, but tooke them upon truſt, from the common received report of Travailers: ſave only that of the two, *Poſidonius* is the more extravagant. Whereas on the contrary *Ptolomy* grounded his opinion on the diſtances of places exactly meaſured, as himſelfe affirmeth; when he ſaith: That the latitude of the knowne parts of the world is 79. degrees, and 45. minutes. Or ſuppoſing it to be full 80. degrees; it will then containe 40000. furlongs, allowing for every degree

five hundred furlongs: as by measuring the distances of places exactly, wee have found it to be.

But *Eratosthenes* is much taxed by *Hipparchus* for his strange mistakes and grosse ignorance in setting downe the distances of places: as *Strabo* testifieth in his first booke. For hee reckons betwixt *Alexandria* and *Carthage* above 13000. furlongs, whereas (saith *Strabo*) it is not above 9000. So likewise *Posidonius* is to bee blamed, for setting downe the distance betwixt *Rhodes* and *Alexandria* to bee 5000. furlongs, and that from the relation of Mariners, whereas some of them would have it to bee but 4000. and others 5000. as *Eratosthenes* confesseth in *Strabo*: but addeth moreover, that hee himselfe had found by Sciotericall instruments, that it was but 3750. And *Strabo* would have it to bee something lesse then that, namely 3640. furlongs. So that hence wee may safely conclude, that *Ptolomies* opinion, being grounded upon the more exact and accurate dimensions of distances, (as himselfe professeth,) must necessarily come nearer the truth then the rest.

But *Franciscus Maurolycus*, *Abbat* of *Messava*, whiles he goes about to defend *Posidonius* against *Ptolomy*, is overtaken himselfe in an errour, before hee is aware. For he suspecteth the truth of *Ptolomies* assignment of the latitude of *Rhodes*, which he sets downe to be thirty sixe degrees. And hee adverti-

seth

ſeth us, that certainly the numbers in his Geographicall tables are corrupted: which, we confeſſe, is moſt certaine. But in the meane time let us ſee how he proves them to be ſo, in this latitude of *Rhodes*. *Poſidonius* (ſaith he) out of his owne obſervations, ſetteth downe the latitude of it to bee thirtie eight degrees and an halfe: unleſſe that *Ptolomy* bee out alſo in deſigning the latitude of *Alexandria*; which *Maurolycus* thinkes cannot poſſibly be. But we affirme on the contrary ſide, that *Ptolomy* himſelfe is againſt this latitude, not onely in his Geographicall bookes, but alſo in diverſe places throughout the *Almageſt* alſo, and eſpecially in the *lib.* 2. *cap.* 6. where he ſets downe the ſame latitude for *Rhodes*, that he hath in his Geography: adding moreover the quantity of the longeſt day, and alſo what manner of ſhadowes the *Gnomons* caſt, both when the Sun is in the *Æ*quinoctiall, as alſo in the Tropickes: all which doe plainly prove the ſame. He alſo very often hath the ſame latitude of it in his Planiſphære: unleſſe you will ſay, that either *Maſſes* the *Arabian*, in tranſlating it into Arabicke, or elſe *Rodulphus Brugenſis*, who tranſlated the ſame againe out of Arabicke into Latine, have deceived us. Hitherto therefore we ſtand on equall tearmes. But he proceeds, and ſaith, that this opinion of *Poſidonius* is favoured alſo by *Proclus*, and the obſervations of *Eudoxus Cnidius* delivered by *Strabo*. Let us therefore ſee what all this is. *Poſidonius* (ſaith *Strabo*) reports, that himſelfe being

ſometime in a City diſtant from the *Gaditane* Straits 400. furlongs, ſaw from the top of an high houſe a certaine Starre, which he tooke to bee *Canobus*: and thoſe that went thence more Southward from *Spaine*, confeſſe that they ſaw it alſo plainely. Now the Tower *Cnidus*, out of which *Eudoxus* is ſaid to have ſeene *Canobus*, is not much higher then the other buildings. But *Cnidus* is in the ſame Climate with *Rhodes*, as is alſo the *Gades*, with the Sea coaſts adjoyning. Thus *Strabo*. But what doth he conclude hence againſt *Ptolomy*? That *Canobus* may be ſeene in *Cnidus*? Wee deny it not. Or that *Cnidus* is in the *Rhodian* Climate? *Ptolomy* acknowledgeth as much: for hee makes it to have not above 36. gr. 15. m. of latitude, in the fifth booke of his *Geography*. But is not *Ptolomy* out alſo in aſſigning the latitude of *Cnidus*? That the latitude of *Rhodes* is no greater then *Ptolomy* hath ſet it, may be proved even out of *Proclus* himſelfe: for he makes the longeſt day at *Rhodes* to be 14. houres and an halfe. And *Ptolomy* will have the ſame to bee equall both at *Rhodes*, and *Cnidus*. And to this aſſenteth *Strabo* likewiſe, ſave onely that in one place he ſets it downe to be but 14. houres bare: ſo that by this reckoning it ſhould have leſſe latitude. Now *Proclus* his words are theſe. In the Horizon of *Rhodes* (ſaith hee) the Summer Tropique is divided by the Horizon in ſuch ſort, as that if the whole circle bee divided into forty eight parts, twenty nine of the ſame

ſame doe appeare above the Horizon, and 19. lye hid under the Earth. Out of which diviſion it followes, that the longeſt day at *Rhodes* muſt be 14. Æquinoctiall houres and an halfe, and the ſhorteſt night, 9. and an halfe, Thus he; I doe not deny, but that *Poſidonius* his ſetting downe of the quantity of the portion of the Meridian intercepted betwixt the verticall point of *Rhodes* and *Alexandria*, might deceive *Pliny*, *Proclus*, and others. Yet *Alfraganus* draweth his ſecond Climate through *Cyprus* and *Rhodes*, and maketh it to have the longeſt day of 14. houres and an halfe, and in latitude 36. gr. two thirds. So that here is but very ſmall difference betwixt him and *Ptolomy*. And even *Maurolycus* himſelfe, when in his Coſmographicall Dialogues he numbreth up the Parallels, hee maketh that which paſſeth through *Rhodes* to have 36. gr. and a twelfth of latitude: herein differing ſomething with the moſt from *Poſidonius*. *Eratoſthenes* his obſervations alſo doe very much contradict *Poſidonius*. For *Eratoſthenes* ſaith, that hee found by Sciotericall Gnomons, that the diſtance betwixt *Rhodes* and *Alexandria* was 3750. furlongs. But let us examine this a little better. The difference of latitude betwixt theſe two places he found Sciotericall, after his manner, to be ſomething more than 5. degrees. And to this difference, (according to his aſſumed meaſure of the compaſſe of the Earth, wherein he allowes 700. furlongs to a degree) hee attributes 3650. furlongs. Neither is there any

other way of working by Scioterical inſtruments (that I know) in finding out the diſtance of furlongs betwixt two places; unleſſe we firſt know the number of furlongs agreeing either to the whole circumference of the Earth, or elſe to the part of it aſſigned. Let us now ſee if we can prove out of the obſervations of *Eratoſthenes* himſelfe, that neither *Poſidonius* his opinion concerning the meaſure of the Earths circumference, much leſſe *Eratoſthenes* his owne can be defended. And here we ſhall not examine his obſervation of the difference of latitude betwixt *Alexandria* and *Syene*, that ſo we might prove out of his own aſſumptions, that the whole compaſſe of the Earth cannot be above 241610. furlongs: as it is demonſtrated by *Petrus Nonius*, in his *lib.* 2. *cap.* 18. *De Navigatione*. Neither doe we enquire, how truely hee hath ſet downe the diſtance of theſe two places to bee 5000. furlongs: whereas *Solinus* reckoneth not from the very Ocean to *Meroë* above 620. miles, which are but 4960. furlongs. Now *Meroë* is a great deale farther than *Syene*. Neither will we queſtion him at all, concerning the ſmall difference that is betwixt him and *Pliny*, who reckons from the Iſland *Elephantina* (which is 3. miles below the laſt Cataract, and 16. miles above *Syene*) to *Alexandria* but 486. miles: ſo that by this reckoning, betwixt *Syene* and *Alexandria*, there will not be above 4560. furlongs. But we will proceed a contrary way to prove our aſſertion. This one thing therfore

we

we require to be granted us; Which is: that looke how great a ſpace the Sunnes Diameter taketh up in his Orbe; for the like ſpace on the *Terreſtriall Globe* ſhall the *Gnomons* be without any ſhadow at all, while the Sunne is in their Zenith. Which if it be granted, (as it is freely confeſſed by *Poſidonius* in *Cleomedes*,) we have then gotten the victory.

Now it is affirmed by *Eratoſthenes*, that the Sunne being in the beginning of Cancer, and ſo directly in their verticall point at *Syene*; both there, and for 3000. furlongs round about, the *Gnomons* caſt no ſhadow at all. Let us now therefore ſee, how great a part of his Orbe the Sunnes Diameter doth ſubtend. For by this meanes, if this poſition of *Eratoſthenes*, which wee have now ſet downe, bee true; we may eaſily finde out by it the whole circuit of the Earth. *Firmicus Maternus* makes the Diameter both of the Sun and Moone to be, no leſſe then a whole degree. But he is too farre from the truth: and aſſigneth a greater quantity, either then he ought, or wee deſire. The *Ægyptians* found by Hydroſcopicall inſtruments, that the Diameter of the Sunne takes up the Seven hundred and fiftieth part of his Orbe. So that if 300. furlongs on Earth anſwer to the ſeven hundred and fiftieth part of the whole circumference of the ſame: the whole circuit of it then will bee but 225000. furlongs. The fabricke and uſe of this inſtrument is ſet downe by *Proclus* in his *cap.* 3. *Deſignation. Aſtronomi.* And *Theon* alſo ſpeaks much

much of it in his Commentaries upon the 5. *lib. Almageſt. Ptolom.* as alſo doth *Maurolycus* in his third *Dialog. Coſmograph.* But theſe kindes of obſervations are not approved of by *Ptolomy*. And *Theon* alſo, and *Proclus* demonſtrate them to bee obnoxious to much errour. And therefore we examine the matter yet a little further.

Ariſtarchus Samius, (as he is cited by *Archimedes*) affirmed, that the Suns apparent Diameter taketh up the ſeven hundred and fiftieth part of the Zodiaque, that is to ſay, 30. minutes; and is equall to the apparent Diameter of the Moon: as he hath it (as I remember) in the 7. and 8. Propoſitions of his booke *De magnitud. & diſtant. Solis & Lunæ.* The ſame was the opinion alſo of *Archimedes* himſelfe. But in the meane time I cannot free my ſelfe of a certaine ſcruple caſt in my way, by another ſuppoſition of the ſame *Ariſtarchus*, in the very ſame booke, where he would have the Diameter of the Moone to bee 2. degrees. *Archimedes* alſo out of his owne obſervations by Dioptricall inſtruments, hath defined the Suns Diameter to bee greater then the 200th part of a right angle, that is to ſay, 27. minutes: yet leſſe then the 164th part of a right angle, which is 33. minutes. But he himſelfe confeſſeth, that there is no ſo great credit to be given to ſuch like obſervations, as are made by theſe Dioptricall inſtruments, as by them to bee able exactly to find out the Diameter of the Sunne or Moone: ſeeing that neither the ſight, nor the hand, nor

yet

yet the inſtruments themſelves, by which the obſervations are to be made, can be every way ſo exact and ſure, as not to faile. *Ptolomy* by the ſame Dioptricall inſtrumemts, as alſo by the manner of Eclipſes, found the Diameter of the Sun to containe 30. m. 20. ſec. and to be equall to the apparent Diameter of the Moone, when ſhe is at the greateſt diſtance from the earth, which is, at the full Moone, and in Conjunction with the Sunne. Now wheras he would have this magnitude to bee conſtantly the ſame, and invariable: *Proclus* approves not of him herein, as appeares in his 3. *cap. Deſignation. Aſtronom.* being hereto induced by the authority of *Soſigenes* a Peripateticke: who in thoſe bookes of his, which he intituleth, *De revolutionibus*, hath obſerved, that in the Eclipſes of the Sun, there is ſometimes a certaine little ring or circle of the Sun to be perceived enlightned, and appearing plainely on all ſides round about the body of the Moone. Which if it be true, it is impoſſible then, that the apparent magnitude of the Sunne ſhould bee at all times equall to that of the Moone in their Conjunctions and oppoſitions. And this is the cauſe perhaps, that thoſe that have come after *Ptolomy*, have endeavoured to examine theſe things more accurately. And firſt of all *Albatenius* found the Diameter of the Sunne, when he was in the *Apogæum* of his Eccentricke, to be 31. m. 20. ſec. which is the ſame with *Ptolomies* obſervation: but in the *Perigæum*, to be 33. m. 40. ſec. But *Copernicus*

pernicus went yet further, and found the Diameter of the Sunne, when he was in his greateſt diſtance from the Earth, to be 31.m. 48. ſec. and when he is neareſt of all, to be 33. m. 54. ſec. Now therefore if we worke upon this ground here laid before us, and take the Diameter to be 32. m. it will then follow, that if 300. furlongs anſwere to 32. minutes, the whole circuite of the Earth will bee but 202500. furlongs : which falls ſhort of that meaſure which *Poſidonius* hath ſet downe, but much more of that which *Eratoſthenes* hath delivered. And thus much have we thought good to ſay (with all due reverence to the judgements of learned Authors) in examination of thoſe things, which have been delivered by the Greekes, concerning the meaſure of the Earths circumference.

The way of meaſuring uſed here with us, is by Miles, and Leagues : of the former whereof 60. and of the later 20. anſwering to a degree. So that the circumference of the Earth, containeth 21600. Engliſh Miles : which alſo agrees exactly with that of *Ptolomy*. For we find our Engliſh foot to be juſt equall with the *Grecian*, by comparing it with the *Grecian* foot, which *Agricola*, and others have delivered unto us, out of their monuments of antiquity. Now one of our Miles containeth 5000. feet of our Engliſh meaſure : and a furlong 600. *Grecian* feet. Now if you multiply the meaſure of a furlong by 500. (for ſo many furlongs doth *Ptolomy* allot to a degree) and

ſo

ſo likewiſe the meaſure of a Mile, which is 5000. feet, by 60. (which is alſo the number of miles that we reckon for a degree,) they will both produce the ſame number of feet, *viz.* 300000. So that from theſe grounds we may certainly conclude, that the common computation received among our Mariners, doth agree moſt exactly with that of *Ptolomy*.

The *Italians* alſo make 60. miles to be the meaſure of a degree: but their meaſure is ſomething leſſe then *Ptolomies*. The *Germans* reckon 15. miles to a degree: one of their miles containing 4. *Italian*: ſo that this reckoning of theirs falls juſt as much ſhort of *Ptolomyes*, as the *Italian* doth. For according to their computation, a degree containeth not above 480. furlongs, every *Italian* Mile conſiſting but of 8. furlongs: (unleſſe perhaps you rather approve of *Polybius* his opinion, who, (as he is cited by *Strabo*,) over and above 8. furlongs, will have 2. *Plethra*, which is the third part of a furlong, to be added to every mile: which is the juſt meaſure of our Engliſh mile.) Yet *Appian* ſaith that 15. *Germane* miles, are as much, as 60. *Italian*: and 60. *Italian* miles containe 480. furlongs: which is leſſe then *Ptolomies* meaſure by 20. furlongs, which make up two *Italian* miles, and an halfe.

The *Spaniards* reckon to a degree, ſome of them 16. leagues and two third parts: and ſome ſeventeene and an halfe. But how their meaſure ſtands, compared with the Grecian furlongs, or with the Engliſh, Italian, or German

mane miles, I have not yet certainely learned. Yet *Nonius* seemeth to equall the Spanish league with the *Schœnus*, or *Parasanga*: which if it be so, then those that allow 16. leagues and 2. thirds to a degree, have the same measure that *Ptolomy* hath delivered: but those that allow 17. and an halfe, make it somewhat too large.

It only now remaineth to see, what is the doctrine of the *Arabians* concerning this matter. Of which the most ancient have assigned to the whole circumference of the Earth, 24000. Miles, or 8000. *Parasangæ*: so that after this computation, a Degree must containe 66. Miles, with two third parts. And this measure is used by *Alhazenus*, in the end of his booke, *De Crepusculis*. *Alfraganus*, and some of the later Arabicke writers, since *Almamons* time, do generally account 20400. Miles to be the just measure of the *Terrestriall Globe*: So that one degree containeth, by this reckoning, 56. Miles and a third part. And it is reported by *Abilfedea*, in the beginning of his Geography, how that by the command of *Almanon*, King of the *Arabians*, or Caliph of *Babylon* there were certaine men employed, who should observe in the plaine field of *Singar* and the adjoyning Sea coasts, (meaning the places in a direct line toward the Pole,) how many miles answered to a degree: and that they found, by just computation, that in going the space of one degree, there were spent full 56. miles without any fractions, and sometime 56. miles, and a third part which make up

1333.

1333. cubits, with two Thirds. But now what proportion the *Arabian* Mile beareth to ours, or the *Italian*, or *Germane* Mile, is not ſo eaſie to determine. Yet I conjecture it cannot be leſſe than tenne furlongs. The *Paraſanga* (as *Iacobus Chriſtmannus* tells us, out of *Abilfedea*, that great *Arabian* Geographer) containeth three *Arabian* Miles, according to the doctrine both of the Ancient, and Moderne Writers among them. Now a *Paraſanga* (as it appeares plainely out of *Herodotus*, *Xenophon*, and others) containeth thirtie furlongs: ſo that by this account every mile muſt comprehend tenne furlongs. And for confirmation of this we may obſerve, that among the Greekes there were two kinds of Cubits in uſe: the one, the common or ordinary Cubit, which contained two foot and an halfe of *Grecian* meaſure, or twenty foure digits, of which ſixteene went to a foot. The other was the Kings Cubit, in uſe among the *Perſians*: which was greater than the common Cubit by three fingers breadth. Now *Alfraganus* affirmeth, that the *Arabian* mile contained 4000. Cubits, according to the ordinary meaſure. So that if this Cubit be equall to the *Grecian* Cubit, one of their miles will then containe 6000. *Grecian* feet, which make up tenne furlongs. Now whereas the *Paraſanga* is reckoned by ſome to containe 40. furlongs, and by others 60. yet no body allotteth to it leſſe then 30. with which later account if we ſhould, with *Herodotus*, *Xenophon*, and others, reſt our ſelves contented

tented (neither indeed is it our intention to ſtand long in diſputing, whether or no in diverſe places, the meaſure of the *Paraſanga* were alſo different, as *Strabo* ſeemes to thinke, who obſerved the very ſame difference in the Egyptians *Schœnus*, when as being conveighed on the River *Nilus* from one City to another, he obſerved that the Egyptians in diverſe places, uſed diverſe meaſures of their *Schœnus*:) I ſay, if we ſhould reſt upon their determination, who aſſigne but 30. furlongs to a *Paraſanga*; then one of the *Arabian* miles will containe tenne furlongs at the leaſt. Which conjectures if they be true, we cannot then aſſent to thoſe learned men, *P. Nonius*, and *Iacobus Chriſtmannus*, who will have the *Arabian* Mile to be all one with the *Italian*.

In this ſo great diverſity of opinions, concerning the true meaſure of the Earths circumference, let it be free for every man to follow whom ſoever he pleaſe. Yet were it not that the later *Arabians* doe countermand us, by propoſing to us their Poſitions, which they averre to have beene grounded upon moſt certaine and exact menſurations of the diſtances of places: we ſhould not doubt to preferre *Ptolomies* opinion before the reſt. And for your better ſatisfaction, I will here propoſe unto your view a liſt of all thoſe opinions, which carry in them any ſhew of probability.

Authors

	{AUTHORS}	{FURLONGS.}
The circuit of the whole earth containeth according to	*Strabo*, and *Hipparchus*,	252000.
	Eratosthenes	250000.
	Posidonius and the Ancient *Arabians*,	240000.
	Ptolomy and our *English-men*	180000,
	The moderne *Arabians*,	204000.
	The *Italians* and *Germans*,	172800.

	{AUTHORS.}	{FURLONGS.}
The measure of a Degree according to	*Strabo*, and *Hipparchus*	700.
	Eratosthenes	694⅔
	Posidonius and the Ancient *Arabians*,	666⅔
	Ptolomy and our *English-men*	500.
	The later *Arabians*,	566⅔
	Italians and *Germanes*	480.

	MILES.		FURLONGS.
The *Italian*		containeth	8.
English			8⅓
Arabian			10.
Germane			32.

POINT. *For the finding out of the circumference or circuit of the* Terrestriall Globe, *these* Hypotheses *are first to bee laid downe for a ground.* 1. *That the greatest circle in the Earth, as well as in the Heavens, is to bee divided into* 360. *parts, or degrees.* 2. *That one of these degrees doth containe* 500. *furlongs, or* 62500. *Romane pases, and* 60. *English miles.* 3. *That* 8. *furlongs, and a third part make an English Mile.*

These things being presupppoſed, we must multiply 360. *degrees by* 60. *miles, which done, the product will be* 21600. *English miles. Or if you multiply* 360. *degrees, by* 500. *furlongs; the whole will be* 180000. *furlongs, which is the measure of the circumference of the Earth.*

So likewise if 360. *be multiplied by* 15. *the whole will be* 5400. *Germane miles: and if the number of the degrees be multiplied by* 25. *there will arise* 9000. *French miles. All which may be thus expressed in a Table.*

A degree containeth	15. *Germane*	Miles, each of wch containe severally	4000.	Pases.
	60. *Italian*		1000	
	60. *English*		1000.	
	25. *French*			
	17½ *Spanish*		2400.	

In like manner the Circumference of the Earth may as easily bee found out by any of the fixed Starres,

Starres, as the Virgins Spike, or the like. For if we take any two places which are ſituate under the ſame Meridian, and the diſtances in a right line exactly knowne, ſo that in both places the Meridian Altitude of the ſame Star be certainly knowne alſo: the difference of its Altitude will be the number of degrees of diſtance betwixt the ſame places. Wherefore ſeeing it is certainly knowne, as we have already ſaid, how many miles anſwer to a degree, it is very eaſie then to gather, how many miles the circumference of the whole Earth is alſo. As for example: ſuppoſe London and Edenburgh in Scotland to be under the ſame Meridian, and the Elevation of the Pole at London to be 52. degrees, and at Edenburgh 56. gr. 20. m. Now if you ſubſtract the leſſer number, which is 52. from the greater, 56. gr. 20. m. the difference will bee 4. gr. 20. m. which being reſolved into minutes, it will be found to bee 260. the diſtance of miles betwixt London and Edenburgh. Therefore wee muſt now ſay, that as 4. gr. 20. m. is to 260. miles: ſo is 360. degrees to 21600. Engliſh miles.

The fourth Part,

Of the Vſe of Globes.

HItherto wee have ſpoken of the *Globe* it ſelfe, together with its dimenſions, circles, and other inſtruments neceſſarily belonging thereto. It remaineth now that we come to the practiſe of it, and declare its ſeverall uſes. And firſt of all it is very neceſſary for the practiſe both of Aſtronomy, Geography, and alſo the Art of Navigation. For by it there is an eaſie and ready way laid downe, for the finding out both of the place of the Sun, the Longitudes, Latitudes, and Poſitions of places, the length of dayes and houres; as alſo for the finding of the Longitude, Latitude, Declination, Aſcenſion both Right and Oblique, the Amplitude of the riſing and ſetting of the Sunne and Starres, together with almoſt an infinite number of other like things. Of the chiefe of all which wee intend here briefely to diſcourſe, omitting the enumeration of them all, as being tedious and not ſutable to the brevity we intend. Now that all theſe things may be performed farre more accurately, by the helpe of numbers,

numbers, and the doctrine of Triangles, Plaines, and Sphæricall bodies, is a thing very well knowne to thoſe that are acquainted with the Mathematickes. But this way of proceeding, beſides that it is very tedious and prolixe, ſo likewiſe doth it require great practiſe in the Mathematickes. But the ſame things may be found out readily and eaſily by the helpe of the *Globe*, with little or no knowledge of the Mathematickes at all.

PONT. *For the better underſtanding of thoſe things which ſhall be ſpoken hereafter, there are two things eſpecially to bee premiſed: the firſt whereof is, concerning the poſition of the* Globe, *and the other Climates. Now touching the poſition of the* Globe, *you are firſt of all to take care that it be plated perpendicularly to the true Horizon. 2. That the diſtinction of the windes anſwer directly to the windes of the reall Horizon, that ſo the Eaſt on your materiall* Globe, *may looke directly toward the true Eaſt of the World. For which purpoſe eſpecially there is uſually placed a Nauticall Compaſſe in the bottome of the frame. When you have thus placed your* Globe, *ſo that it may be turned about any way at pleaſure, yet ſo that the baſe or foot be not moved out of its place, the next thing that is to be enquired after, is the latitude of the place wherein you live: which according as it is greater, or leſſe, you muſt elevate the Pole of your* Globe *above the Horizon proportionably. As for example, if the latitude be 50. 51. or 52. grad. or more, or leſſe Northward, then muſt you elevate the Articke Pole juſt ſo many*

degrees above the Horizon. And so likewise if the latitude be Southerne, you must doe the like by the Antartick or South Pole. But under the Æquator, where there is no latitude at all, both the Poles must be placed in the very Horizon, at oppo site points.

2. A Climate is a space of the habitable parts of the Earth, comprehended betwixt two circles parallel to the Æquator, in which space there is halfe an houres difference in the longest day. Now those that inhabite under the Æquator have a perpetuall Æquinoxe, for the day with them is alwayes twelve houres long, and the night as much. But as their situation is removed from the Æquinoctiall nearer to either Pole, the farther they are from the Æquinoctiall, the greater is the inequality of the Artificiall day and night: out of which variation of Artificiall daies, the diversity of Climates also is taken and distinguished. For whereſoever this difference amounteth to halfe an houre, there presently beginnes another Climate. Now the ancient Geographers constituted in every Clime three Parallels, of which the two outwardmost, namely the first and the third, do comprehend and terminate every Climate: and the second divideth it in the midst. So that the proportion betwixt the Clime and the Parallels was Duple; for the Climes, as wee have said, were distant from each other halfe an houres space in the length of the day, but the Parallels were distinguished by quarters of an houre.

Now as concerning the number of Climates,

The

The Ancients at first reckoned but seven, but Ptolomy *in his Tables of Ascensions, in the* 2. lib. May. Construction. *acknowledgeth nine: all of which derived their names from some eminent place, either hill or river, situate in the midst of the said Climate. The first Clime toward the Arcticke Pole, beginning from the Æquator, they called* Diameroës, *because the midst of this Climat runneth through* Meroë, *which is an Iland in* Africke *encompassed about with the river* Nilus, *where the longest day is thirteene houres: in the beginning therefore of this Clime it must bee* $12\frac{3}{4}$. *houres long. On the opposite part of the Æquator, the first Southerne Climate may in like manner bee called,* Antidiameroës. *But these other Climes were not constituted neither by* Ptolomy, *nor any of the ancient Geographers. Yet by the like reason that part of the world also may as well be distributed into Climats, reserving the same names that the Northerne Climes are known by, and onely adding to them the preposition* ἀντὶ, *which signifies as much as, Opposite, or over against. And then the Scheme of them all will be thus.*

Northerne Climates.	*Southerne Climates.*
1. Diameroës.	1. Antidiameroës.
2. Diasyenes.	2. Antidiasyenes.
3. Dialexandrias.	3. Antidialexandrias.
4. Diarhodu.	4. Antidiarhodu.
5. Diarhomes.	5. Antidiarhomes.
6. Diapontu.	6. Antidiapontu.
7. Diaboristhenes.	7. Antidiaboristhenes.
8. Diabritanias.	8. Antidiabritanias.
9. Diatanaidos.	9. Antidiatanaidos.

Yet some there are, that doe not approve of this distinction of Climates, among whom is Ioh. Gigas, *in his* lib. 2. System. Geograph. cap. 2. probl. 12. *and the reasons they alleadge are these.* 1. *Because of their great inequality; in so much that the latitude of the first is above* 470. *English miles, whereas the last of all is scarce a mile.* 2. *Because that the encrease of houres is but a weake ground to build upon, and of no great use: seeing it is as easie to enquire out the length of the day, as the number of the Climate. And therefore he thinkes, it were farre better, that every Hemisphære were equally distinguished by tenne degrees into nine Climates. So that the first Climate should begin at the Æquinoctiall, and end where the Elevation of the Pole is tenne gr. which might bee called, the* Æthiopian *Climate. The second should reach to the* 20. *gr. and should bee named the* Arabian *Clime: because that part of* Arabia Fœlix *is situate therein. The third should reach to the* 30. *gr. and be called the* Ægyptian. *The fourth the* Syrian, *ending at the* 40. *gr. The fifth the* Italian, *to the* 50. *gr. The* 6. *the* English, *or* Germane, *extending to the* 60. *gr. The seventh the* Suecian, *or* Lapland *Climate, reaching to the* 70. *gr. The eighth, the* Frozen *Climate, ending at the* 80. *gr. and the ninth and last the* Polar *Climate, reaching to the Pole it selfe.*

So likewise the same Method might be observed on the other side of the Æquinoctiall: and then by this meanes each Hemisphære should have nine Climates: whereof seven would be conveni-

ent

ent for habitation, and the Parallels might passe through every fifth degree. And the situation of any place might bee knowne by the number of degrees of the Poles elevation. So Rome, because it hath above 40. gr. of latitude, is in the fourth; Westphalia in the fifth; Sicily in the third; Calecut, the chiefe City in India, in the second; Zeilan in the first; and so of the rest.

CHAP. I.

How to finde the Longitude, Latitude, Distance, and Angle of Position, or situation of any place expressed in the Terrestriall Globe.

THe Ancient Geographers from *Ptolomies* time downeward, reckon the longitude of places from the *Meridian* which passeth through the *Fortunate Islands*: which at the same that are now called the *Canary Islands*, as the most men doe generally beleeve; but how rightly, I will not here stand to examine. I shall only here advertise the reader by the way, that the latitude assigned by *Ptolomy* to the *Fortunate Islands*, falleth something of the widest of the *Canary Islands*, and agreeth a great deale nearer with the latitude of those Islands which are knowne by the name of *Cabo Verde*. For *Ptolomy* placed all the *Fortunate* Islands within the 10. gr. 30. m. and the 16. gr. of Northerne latitude. But the *Canary Islands* are found

found to be distant from the *Æquator* at the least 27. degrees. The *Arabians* began to reckon their longitude, at that place where the *Atlanticke* Ocean driveth fartheſt into the maine land; which place is tenne degrees diſtant Eaſtward from the Fortunate Iſlands: as *Jacobus Chriſtmannus* hath obſerved out of *Abilfedea*. Our Moderne Geographers for the moſt part beginne to reckon the longitude of places from theſe *Canary* Iſlands: yet ſome beginne at thoſe Iſlands which they call *Azores*: and from theſe bounds are the longitudes of places to be reckoned in theſe *Globes* whereof we ſpeake.

Now the longitude of any place, is defined to be, an Arch, or portion of the *Æquator* intercepted betwixt the Meridian of any place aſſigned, and the Meridian that paſſeth thrcugh Saint *Michaels* Iſland (which is one of the *Azores*) or of any other place, from whence the longitude of places is wont to be determined.

Now if you deſire to know the longitude of any place expreſſed in the *Globe*: you muſt apply the ſame place to the Meridian, and obſerving at what place the Meridian cutteth the *Æquator*, reckon the degree of the *Æquator* from the Meridian of Saint *Michaels* Iſland to that place: for ſo many are the degrees of longitude of the place you looke for.

In the ſame manner may you meaſure the difference of longitude betwixt any other two places that are deſcribed in the *Globe*. For the

difference

difference of longitude is nothing elſe, but an Arch of the Æquator intercepted betwixt the Meridians of the ſame places. Which difference of longitude, many have endeavoured to ſet downe diverſe wayes how to find by obſervation. But the moſt certaine way of all for this purpoſe, is confeſſed by all learned Writers to be, by the Eclipſes of the Moone. But now theſe Eclipſes happen but ſeldome, but are more ſeldome ſeene, yet moſt ſeldome and in very few places obſerved by the skilfull Artiſts in this Science, So that there are but few longitudes of places deſigned out by this meanes. *Orontius Finæus*, and *Iohannes Wernerus* before him, conceived that the difference of longitude might be aſſigned, by the known (as they preſuppoſe it) motion of the Moone, and the paſſing of the ſame through the Meridian of any place. But this is an uncertaine and tickliſh way, and ſubject to many difficulties. Others have gone other wayes to work: as namly, by obſerving the ſpace of the Æquinoctiall houres betwixt the Meridians of two places: which they conceive may be taken by the helpe of Sunne Dials, or Clocks, or Houreglaſſes either with water or ſand, or the like. But all theſe conceits long ſince deviſed, having beene more ſtrictly and accurately examined, have beene diſallowed and rejected by all learned men, (at leaſt thoſe of riper judgements) as being altogether unable to performe that which is required of them. But yet for all this, there are a kind of trifling Impoſtors

postors, that make publike sale of these toyes or worse, and that with great ostentation and boasting; to the great abuse and expense of some men of good note and quality, who are perhaps better stored with money, then either learning or judgement. But I shall not stand here to discover the errours and uncertainties of these instruments. Only I admonish these men by the way, that they beware of these fellowes; least when their noses are wiped (as we say) of their mony, they too late repent them of their ill-bought bargaines. Away with all such trifling cheating rascals.

PONT. *If you would know how to find out the longitude of any place by the Eclipse of the Moone, you must first goe to some* Ephemerides, *as the Prutenicke Tables, or of any other learned Mathematicians calculation; and see, what houre such an Eclipse of the Moone shall happen at that place, for which the said Tables or* Ephemerides *were made. Then afterward you must observe the same Eclipse in that place, whose longitude you desire to know. Now if the time of the Eclipse agree with that other, for which the Tables were made, then you may conclude that both places have the same latitude, and are situate under the same Meridian. But if the number of the houres be more, then the place you are in is situate more Eastward, you must therefore substract the lesse number out of the greater, and the remainder must be converted into degrees and minutes, multiplying the houres by fifteene and dividing the minutes of houres (if there be any) by foure;*

foure; for so will the number of degrees arise: and if there remaine any minutes after the division, they must be multiplied againe by fifteene, and so will the number of the minutes of degrees arise, by which these places are distant from each other: which distance is called the difference of longitude. This difference must bee added to the longitude of that place for which the Tables were calculated, if the other place be more Eastward; otherwise if it be more Westward, it is to be substracted from the longitude of the other. An example hereof is thus proposed by Adrianus Metius in his Doctrina Sphærica. I find (saith he) out of the Prutenicke Tables by exact calculation, that there will be an Eclipse of the Moone in the yeare 1598. upon the eleventh day of Frebruary, at foure of the clocke and sixteene minutes, in the morning, and that at Regiomont, a City in Borussia, whose longitude, or distance from the Canary Islands, is 41. gr. 16. m. For this longitude were these Tables calculated. Now I set my selfe to observe this same Eclipse at Marpurg, and find it to happen at three of the clocke and twelve minutes, on the same day of February. Now because the number of houres here is lesse, it appeares that Marpurg is more Westward then Regiomont. Therefore I take away the lesse number from the greater, that is, 3. h. 12. m. from 4. h. 16. m. and the remainder is 1. h. 4. minutes: which sheweth the difference of longitude in houres, which make up sixteene degrees. Therefore I againe substract these degrees of difference from the longitude of Regiomont, as being more Eastward

then

then Marpurge; *and ſo I find the longitude of* Marpurge *from the* Canary *Iſlands, to be* 25. *gr.* 16. *minutes.*

CHAP. II.

How to finde the Latitude of any place.

THe latitude of a place, is the diſtance of the Zenith, or the verticall point thereof from the Æquator. Now if you deſire to find out the latitude of any place expreſſed in the *Globe*, you muſt apply the ſame to the Meridian, and reckon the number of the degrees that it is diſtant from the Æquator: for ſo much is the latitude of that place. And this alſo you may obſerve, that the latitude of every place is alwayes equall to the elevation of the ſame place. For look how many degrees the verticall point of any place is diſtant from the Æquator, juſt ſo many is the Pole elevated above the Horizon: as you may prove by the *Globe*, if you ſo order it, as that the Zenith of the place be 90. degrees diſtant every way from the Horizon.

PONT. *Seeing that the latitude of every place is alwayes equall to the elevation of the Pole: It will not be amiſſe to ſhew, how the elevation of the Pole, or the latitude of any region may be found out, by the obſerving of ſome fixed Starre in the heavens, which is ſo neare the Pole, as that it never ſets in that region: which to doe you muſt worke thus. You muſt obſerve both the leaſt and alſo the greateſt altitude of the ſaid Starre;*

Starre; both which muſt neceſſarily happen in the Meridian: the leaſt whereof will be beneath the Pole, and the greateſt above it. Which done, you muſt adde the leaſt altitude of it to the greateſt: and ſo the halfe of the degrees thus numbred together, will be the altitude of the Pole, and latitude of that place. An example whereof may be this. The firſt Starre of the three in the taile of the great Beare is in his leaſt altitude obſerved at London *to be about* 11. *gr. and the greateſt altitude of the ſame, when it is above the Pole, is found to be neare upon* 92. *degrees. Both which numbers being added together, doe make up* 103. *halfe of which ſumme, namely* $51\frac{1}{2}$. *is the true elevation and latitude of* London.

Chap: III.

How to find the diſtance of two places, and angle of poſition, or ſituation.

IF you ſet your *Globe* in ſuch ſort, as that the Zenith of one of the places be 90. gr. diſtant every way from the Horizon, and then faſten the Quadrant of Altitude to the Verticall point, and ſo move it up and downe, untill it paſſe through the Vertex of the other place: the number of degrees intercepted in the Quadrant betwixt the two places, being reſolved into furlongs, miles, or leagues, (as you pleaſe) wil ſhew the true diſtance of the places aſſigned. And the other end of the Quadrant, that toucheth

toucheth upon the Horizon, will ſhew on what wind or quarter of the world the one place is in reſpect of the other, or what Angle of Poſition (as they call it) it hath. For the Angle of Poſition is that, which is comprehended betwixt the Meridian of any place, and a greater circle paſſing through the Zeniths of any two places aſſigned: and the quantity of it, is to bee numbred in the Horizon.

As for Example. The longitude of *London* is twentie ſixe degrees, and it hath in Northerne latitude 51. degrees, and an halfe. Now if it be demanded, what diſtance and angle of poſition it beareth to Saint *Michaels* Iſland, which is one of the *Azores*: we muſt proceed thus to find it. Firſt, let the North Pole bee elevated $51\frac{1}{2}$. degrees: which is the latitude of *London*. Then faſtning the Quadrant of Altitude to the Zenith of it, that is to ſay, fiftie one degrees and an halfe Northward from the Æquator, we muſt turne it about, till it paſſe through Saint *Michaels* Iſland: and we ſhall finde the diſtance intercepted betwixt theſe two places to be 11. gr. 40. m. or thereabout: which is 280. of our leagues. And if we obſerve, in what part of the Horizon the end of the Quadrant reſteth, we ſhall find the Angle of Poſition to fall neare upon 50. gr. betwixt Southweſt and by-weſt. And this is the ſituation of this Iſland in reſpect of *London*.

PONT. *The diſtance of places differing only in latitude may bee found after this manner.*

Firſt

Firſt you muſt ſubſtract the leſſer latitude from the greater, reſolving a degree into minutes, if the ſubſtraction cannot be done otherwiſe conveniently. Then multiply the degrees by 15. *and divide the minutes by* 4. *and the ſumme produced will be the diſtance of thoſe two places in common* Germane *miles, one whereof containeth foure of our* Engliſh *miles. As for example:* Baſile *in* Germany, *and* Geneva *have both the ſame longitude; but differ in latitude, which at* Baſill *is* 47. *gr.* 30. *m. and at* Geneva 45. *gr.* 45. *m. Therefore ſubſtracting the leſſer from the greater, the remainder will be* 1. *gr.* 45. *m. which being reduced into* Germane *miles, will amount to* 26. *and a quarter of a mile: which is the diſtance of theſe two places aſſined.*

Now if the places propoſed be in diverſe Hemiſphæres, then the degrees and minutes of latitude muſt firſt be added together, and ſo the whole reſolved into miles, as formerly hath beene ſaid: As for example: The Cape of good hope *in* Africa, *and* Conſtantinople *are almoſt ſituate under the ſame Meridian, but in diverſe Hemiſphæres. Now the elevation of the Pole Articke at* Conſtantinople *is* 43. *gr. or thereabout: and at the* Cape of good hope *the Antartike Pole is elevated about* 35. *gr. the whole ſumme therefore is* 78. *degrees, that is to ſay,* 1170. Germane *miles.*

The diſtance of places differing only in longitude, is found thus. Firſt ſubſtract the leſſe number from the greater: then looke in the Table hereunder written, how many miles anſwer to a degree in evere Parallel, ſeeking for the degree of lati-

tude in the first columne descending, and the number of miles over against it. Then lastly let the difference of longitude be multiplied into miles and minutes: and you have your desire. As for example: Naples *and* Ilium, *or* Troy, *are in the same latitude of fortie one gr. where eleven* Germane *miles, and nineteene minutes answer to a degree of that Parallel: but these places differ in longitude, which at* Naples *is* 39. *gr.* 30. *m. but at* Troy 55. *gr.* 50. *m. Now the difference betwixt them, is* 16. *gr.* 20. *m. which is as much as* 184. Germane *miles, and fiftie scruples: the just distance betwixt these two places.*

| Miles. | | |

The Longitude or Latitude of any place or City being knowne, either by observation, as hath already beene shewed, or else out of some Geographicall Table, the situation of the same in the Globe may also bee found out by this meanes. You must first reckon the Longitude of your place, among the circles of Longitude which are described upon the Globe, beginning at that which is drawne through the Fortunate Islands: and observe the circle where you end your reckoning. Then if the Latitude of your place bee Northerne: you must reckon that also among the Parallels toward the Arcticke Pole, beginning from the Æquator: but if it have Southerne Latitude, you must then proceede in like manner, but reckon toward the Antarctique. And the Intersection, or poynt where these two circles cut each other, sheweth the situation of your place. But if these circles of Longitude be not expressed in your Globe, then must you place that degree of the Æquinoctiall, that answereth to the Longitude of your place, under the Meridian, and so reckon the Latitude of your place among the degrees of the Meridian, toward either Pole: and you have the situation of the place you looke after.

A Table of the *Longitudes* and *Latitudes* of some certaine Cities of note.

	Longit.	Latit.
Alexandria	60. 30	43. 42
Amsterdam	21. 43	52. 30
Antwerp	20. 16	51. 28
Athens	52. 45	37. 15
Bruxells	20. 42	51. 0
Bremen	35. 16	53. 40
Bamberg	28 10	49. 56
Basell	24. 22	47. 41
Bononia	32. 5	43. 54
Constantin.	56. 0	42. 5
Cassell	26. 36	51. 43
Colen	33. 26	51. 0
Corinth	31. 15	36. 55
Dresden	38. 5	51. 6
Dover	28. 10	51. 0
Dantzik	39. 2	54. 54
Dublin	16. 40	53. 10
Erford	28. 40	51. 10
Estinga	26. 36	48. 39
Francford ad Mæn.	25. 38	50. 12
Ferraria	32. 15	44. 23
Genua	28. 20	43. 50
Gant	19. 8	51. 24
Græningen	22. 54	53. 16
Heidelberg	25. 38	49. 35
Jena	29. 2	51. 8
Lubeck	28. 30	54. 48
Leiden	20. 47	52. 10
Regius Mos Boruss.	46. 45	54. 21
London	25. 50	51. 32
Marpurg	25. 16	51. 0
Millaine	38. 20	45. 6
Norimberg	28. 20	49. 24
Naples	30. 10	41. 0
Orleans	15. 36	47. 16
Oxford	24. 0	52. 0
Prage	32. 0	50. 6
Paris	25. 25	48. 30
Ratisbane	29. 50	48. 56
Rostock	30. 14	54. 36
Spier	35. 39	49. 20
Tubing	20. 23	48. 38
Vienna	34. 36	47. 44
Yorke	23. 30	54. 30

CHAP. IV.

To finde the Altitude of the Sunne, or other Starres.

THE Altitude of the Sunne, or other Starre, is the distance of the same, reckoned in a greater Circle, passing the Zenith of any place and the body of the Sunne, or Starre. Now that the manner of observing the same is to be performed either by the Crosse Staffe, Quadrant, or other like Instrument, is a thing so well knowne, as that it were vaine to repeat it. *Gemma Frisius* teacheth a way, how to observe the Altitude of the Sunne by a Sphæricall Gnomon. But this way of proceeding is not so well liked, as being subject to many difficulties and errours: as, whosoever proves it, shall easily find.

CHAP. V.

To finde the place and Declination of the Sunne, for any day given.

HAving first learned the day of the moneth, you must looke for the same in the Calendar described on the Horizon of your Globe. Over against which, in the same Horizon, you shall find the Signe of the Zodiaque,

aque, and the degree of the ſame, that the Sunne is in at that time. But if it be Leape yeare, then for the next day after the 28th. of February you muſt take that degree of the Signe, which is aſcribed to the day following it. As for example, if you deſire to know, what degree of the Zodiaque the Sunne is in, the 29th. of February, you muſt take that degree which is aſſigned for the firſt of March, and for the firſt of March, take the degree of the ſecond; and ſo forward. Yet I ſhould rather counſell, if the place of the Sunne be accurately to be knowne, that you would have recourſe to ſome Ephemerides, where you may have the place of the Sunne exactly calculated for every day of the yeare. Neither indeede can the practiſe by the Globe in this caſe be ſo accurate, as often times it is required to bee.

Now when you have found the place of the Sunne, apply the ſame to the Meridian, and reckon thereon how many degrees the Sunne is diſtant from the Æquator, for ſo many will the degrees be of the Sunnes declination for the day aſſigned. For the Declination of the Sunne, or of any other Starre, is nothing elſe but the diſtance of the ſame from the Æquator, reckoned on the Meridian. But the Sunnes Declination may be much more exactly found, out of thoſe Tables which Mariners uſe, in which the Meridian Altitude, or Declination of the Sunne for every day in the yeare, and the quantity of it is expreſſed. One thing I ſhall

give you notice of by the way; and that is, that you make uſe of thoſe that are lateſt made, as neare as you can. For all of them, after ſome certaine ſpace of time, will have their errours. And I give this advertiſement the rather, for that I have ſeene ſome, that having ſome of theſe Tables, that were very ancient, and written out with great care and diligence, (which notwithſtanding would differ from the later Tables, and indeed from the truth it ſelfe, often times at leaſt 10. *m.* and ſometimes more) yet would they alwayes uſe them very conſtantly and with a kinde of religion. But theſe men take a geat deale of paines and care to bring upon themſelves no ſmall errors.

PONT. *You alſo finde out the Sunnes greateſt Declination, by his greateſt and leaſt Altitude both in Summer and Winter, by ſubſtracting the leaſt out of the greateſt. For then halfe that which remaineth, will be the declination you ſeeke for So* Regiomontanus *at* Vienna *found the Meridian Altitude of the Sunne, at the Summer Solſtice, to be* 65. gr. 30. m. *and the leaſt Altitude of it, on the Winter Solſtice, to be* 18. gr. 30. m. *when therefore he had deducted the leaſt number,* 18. gr. 30. m. *out of* 65. gr. 30. m. *he found the remainder to be* 47. gr. 0. m. *the halfe of which was the Sunnes greateſt declination, namely* 23. gr. 30. m. *which is the number of degrees now commonly received: notwithſtanding it hath beene ſince obſerved by ſome in our time to be ſomewhat leſſe.*

Now to know the Longitude of the Sunne for any

any time, that is to ſay, in what degree of the Zodiaque hee is, you muſt doe thus. Seeke in the limbe of the Horizon for the day of the Moneth, for which you would know the Longitude of the Sunne: which found, you ſhall ſee over againſt it, among the Signes of the Zodiaque deſcribed alſo upon the Horizon, the degree of the Signe that exactly anſwereth to it, and which is the place of the Sunne for that day and Moneth. But if it bee Leape yeare, you muſt remember after the 28th. *of February, to adde one day more ſtill as you go: as if you ſhould looke for the place of the Sunne on the* 13th. *March, you muſt take that degree which is ſet for the* 14th. *of March: which is the* 3. gr. *of* ♈.

Chap. VI.

How to finde the Latitude of any place, by obſerving the Meridian Altitude of the Sunne, or other Starre.

OBſerve the Meridian Altitude of the Sunne with the Croſſe Staffe, Quadrant, or other like inſtrument, and having alſo found the place of the Sunne in the Eclipticke, apply the ſame to the Meridian, and ſo move the Meridian up and downe through the notches it ſtands in, untill the place of the Sunne be elevated ſo many degrees above the Horizon, as the Sunnes Altitude is. And the Globe ſtanding in this poſition,

poſition, the Elevation of either of the Poles will ſhew the Latitude of the place wherein you are. An example whereof may bee this.

On the 12th. of Iune, according to the old Iulian account, the Sunne is in the firſt degree of *Cancer*, and hath his greateſt declination $23\frac{1}{2}$ degrees. And on the ſame day ſuppoſe the Meridian Altitude of the Sunne to be 50. degrees. We enquire therefore now, what is the Latitude of the place where this obſervation was made. And this we finde out after this manner. We apply the firſt degree of *Cancer* to the Meridian, which we move up and downe, till the ſame degree be elevated above the Horizon 50. degrees: which is the Meridian Altitude of the Sunne obſerved. Now in this poſition of the Globe, we find the North Pole to bee elevated 63. *gr.* and an halfe: So that we conclude this to be the Latitude of the place, where our obſervation was made.

The like way of proceeding doe Mariners alſo uſe, for the finding out of the Latitude of places by the Meridian Altitude of the Sunne, and their Tables of Declinations: But I ſhall not here ſpeake any further of this, as well for that the explication hereof doth not ſo properly concerne our preſent intention: as alſo becauſe it is ſo well knowne to every body, as that the handling of it in this place would be needleſſe and ſuperfluous.

The like effect may be wrought by obſerving the

the Meridian altitude of any other Starre expreſſed in the *Globe*. For if you ſet your *Globe* ſo, as that the Starre you meane to obſerve, be ſo much elevated above the Horizon, as the Meridian Altitude of it is obſerved to be: the elevation of the Pole above the Horizon will ſhew the latitude of the place. But here I ſhould adviſe, that the latitude of places bee rather enquired after by the Meridian Altitude of the Sunne, then of the fixed Starres: becauſe the declinations, as wee have already ſhewed, are very much changed, unleſſe they be reſtored to their proper places by later obſervations.

Some there are that undertake to performe the ſame, not only by the Meridian Altitude of the Sunne or Starre, but alſo by obſerving it at two ſeverall times, and knowing the ſpace of time, or Horizontall diſtance betwixt the two obſervations. But the practiſe hereof is prolixe and doubtfull: beſides that by reaſon of the multitude of obſervations that muſt bee made, it is alſo ſubject to many errours and difficulties. Notwithſtanding the eaſieſt way of proceeding that I know in this kind, is this that followeth.

To

To find out the Latitude of any place, by knowing the place of the Sunne, or other Starre, and obſerving the Altitude of it two ſeverall times, with the ſpace of time betwixt the two Obſervations.

FIrſt having taken with your Compaſſes the complement of the Altitude of your firſt Obſervation, (now the complement of the Altitude is nothing elſe, but the difference of degrees by which the altitude is found to be leſſe then 90. degrees,) you muſt ſet one of the feet of your Compaſſes in that degree of the Ecliptique that the Sunne is in at that time: and with the other deſcribe a circle upon the ſuperficies of the *Globe*, tending ſomewhat toward the Weſt, if the obſervation be taken before noone, but toward the Eaſt, if it be made in the afternoone. Then having made your ſecond obſervation, and obſerved the ſpace of time betwixt it and the former, apply the place of the Sunne to the Meridian, turning the *Globe* toward the Eaſt, untill that ſo many degrees of the Æquator have paſſed by the Meridian, as anſwer to the ſpace of time that paſſed betwixt your obſervations, allowing for every houre fifteene degrees in the Æquator, and marking the place in the Parallel of the Sunnes declination that the Meridian croſſeth

ſeth after this turning about of the *Globe*. And then ſetting the foot of your Compaſſes in the very Interſection, deſcribe an Arch of a Circle with the other foot of the Compaſſe extended to the complement of the ſecond obſervation, which Arch muſt cut the former circle. And he common Interſection of theſe two circles, twh ſhew the verticall point of the place willerein you are: ſo that having reckoned the diſtance of it from the *Æquator*, you ſhall preſently have the latitude of the ſame.

The ſame may be effected, if you take any Starre, and work by it after the ſame manner: or if you deſcribe two circles mutually croſſing each other, to the complements of any two Starres.

PONT. *The Meridian altitude of the Sun being found by the helpe of the Meridian circle, it will be very eaſie to find out the latitude of the place, or elevation of the Pole, in any region whatſoever. For ſeeing the Zenith or Vertex of every place is diſtant a quarter of a circle that is* 90. *degrees from the Horizon: if then, the Sun being in either of the Æquinoctiall points, the Meridian altitude be ſubſtracted from* 90. *degrees; the remainder will be the diſtance betwixt the Zenith of the place and the Æquinoctiall circle: which will be the latitude of the ſame place. And the reaſon alſo of this deduction is manifeſt, becauſe that the Æquinoctiall Altitude of the Sun, is nothing elſe, but the Elevation of the Æquator, the complement whereof is alwayes equall to the elevation of the Pole. But this will appeare more plaine by an example,*

example, which shall be thus. The Æquinoctiall altitude of the Sunne at Rome *is* 40. *degrees: which being substracted from* 90. *gr. the remainder, which is* 42. *gr. is the elevation of the Pole, and the latitude of* Rome, *So likewise here at* London *the Meridian altitude of the Sunne, when he is in the Æquinoctiall, is found to be* 38. *degrees and an halfe: which being deducted out of* 90. *gr. which is the Quadrant of a circle, there will remaine* $15\frac{1}{2}$ *gr. which is the latitude of* London, *and the elevation of the Pole.*

The same also may be done, by observing any one of the fixed Starres, which is so neare the Pole, as that it never sets in that Countrey, whose latitude you seeke. For you must observe both the greatest and least altitude of the same Starre; both which will happen in the Meridian: the least of them beneath the Pole, and the greatest above it. Which done, you must adde the least altitude to the greatest, and so dividing the whole into two parts, the halfe will be the altitude of the Pole. As hath beene shewed before.

CHAP.

Chap. VII.

How to find the Right and Oblique Aſcenſion of the Sunne and Starres, for any Latitude of place, and time aſſigned.

THe Aſcenſion of the Sun or Stars, is the degree of the Æquator that riſeth with the ſame above the Horizon. And the Deſcenſion of it, is the degree of the Æquator, that goes under the Horizon with the ſame. Both theſe is either Right, or Oblique. The Right Aſcenſion or Deſcenſion is the degree of the Æquator that aſcendeth or deſcendeth with the Sunne, or other Starre, in a Right Sphære: and the Oblique is the degree that aſcendeth, or deſcendeth with the ſame in an Oblique. The formes of theſe is ſimple and of one kind only: becauſe there can be but one poſition of a Right Sphære. But the later is various and manifold, according to the diverſe Inclination of the ſame.

Now if you deſire to know the Right Aſcenſion or Deſcenſion of any Starre, for any time and place aſſigned: apply the ſame Star to the Meridian of your *Globe:* and that degree of the Æquator that the Meridian croſſeth at that ſituation of the *Globe*, wil ſhew the Right Aſcenſion and Deſcenſion of the ſame, and alſo divideth each Hemiſphære in the midſt at the ſame time with it.

And

And if you would know the Oblique Aſcenſion or Deſcenſion of any Starre, you muſt firſt ſet the *Globe* to the latitude of the place, and then place the Starre at the Eaſterne part of the Horizon: and the Horizon will ſhew in the Æquator the degree of Oblique Aſcenſion. And if you turne it about to the Weſt ſide of the Horizon, the ſame will alſo ſhew in the Æquator the Oblique Deſcenſion of that Starre. In like manner may you find out the Oblique Aſcenſion of the Sunne, or any degree of the Eclipticke, having firſt found out, in the manner wee have formerly ſhewed the place of the Sunne. And hence alſo may bee found the difference of the Right and Oblique Aſcenſion, whence ariſeth the diverſe length of dayes.

As for example. The Sunne entreth into Capricorne on the eleventh day of *December*, according to the old account. I would now therefore know the Right and Oblique Aſcenſion of this degree of the Eclipticke, for the latitude of fiftie two degrees. Firſt, therefore I apply the firſt degree of Capricorne to the Meridian: where I find the ſame to cut the Æquator at 270. gr. which is the degree of the Right Aſcenſion. But if you ſet the *Globe* to the latitude of fiftie two degrees, and apply the ſame degree of Capricorne to the Horizon; you ſhall find the 303. gr. 50. m. to riſe with the ſame. So that the difference of the Right Aſcenſion 270. and the Oblique 303. gr. 50. m. will be found to be 33. gr. 50. minutes.

PONT.

PONT. *This Aſcenſion and Deſcenſion is alſo called the Aſtronomicall riſing and ſetting of the Stars: and that in reſpect of the Arches and parts of the Ecliptique, or Starres, either above or beneath the Horizon. Now an Arch of the Ecliptique or Zodiaque is to bee underſtood two manner of wayes: namely Continued, or Diſcrete. A continued Arch, is when it is reckoned in the Æquator in a continued Series from the beginning of* Aries, *and ſo forward into the conſequent ſignes. A Diſcret Arch is ſo called, becauſe it is not reckoned from the firſt degree of* Aries, *but from any other point in the Æquator: as if you ſhould ſay, an Arch from the* 14. *gr. of* Gemini *to the* 14. *gr. of* Taurus.

Beſide, this Right Aſcenſion is called alſo the greater Aſcenſion, becauſe that in it a greater Arch of the Æquator riſeth above the Horizon, then of the Zodiaque: and it is called Right, becauſe that in this the Angle which is made by the Horizon and Ecliptique, is nearer to a Right Angle, then that is made by any other part of the Ecliptique with the ſame. And that is ſaid to be a greater Arch or portion of the Æquator, which is more than 30. *degrees in the Aſcenſion or Deſcenſion: and that is called a leſſer Arch, which falls ſhort of thirtie degrees in riſing or ſetting.*

In a Right Sphære foure ſignes onely aſcend Rightly, which are Gemini, Cancer, Sagittarius, *and* Capricornus: *all the reſt aſcend Obliquely.*

In an Oblique Sphære ſixe ſignes riſe Rightly,

and the other sixe Obliquely. The right are these, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius: *and all the rest Obliquely.*

Oblique Ascension, is when a lesse Arch or portion of the Æquator riseth, then of the Zodiaque: or else, that Starre may be said to rise Obliquely, with whom a lesse portion of the Æquator ascendeth above the Horizon. And so the Oblique descension or setting of a Starre is, where a lesse portion of the Æquator descendeth with it. As for example. At Rome *with the Arch of* Libra, *which containeth* 30. *gr. in the Zodiaque, their riseth an arch of the Æquinoctiall of* 37. *gr. So that this signe is said there to rise rightly: Because that a greater Arch of the Æquator ascendeth with it, then of the Zodiaque. But then at the same place with the Arch of* Aries, *there arise only* 17. *gr. of the Æquator. Whence it followeth that* Aries *riseth Obliquely at* Rome. *In our position of Sphære also here at* London, *which is Oblique, like as that at* Rome, *with* Libra *there ariseth an Arch of the Æquinoctiall containing about* 41. *gr. but with the Arch of* Aries *there ariseth not above* 13. *degrees. Therefore in our Sphære* Libra *ascendeth or riseth rightly, but* Aries *Obliquely.*

Certaine Rules, for the Astronomicall rising in a Right Sphære.

THe Rules of Astronomicall rising in a right Sphære are these. 1. *The whole Quadrants or quarters of the Zodiaque and Æquinoctiall rise*

riſe and ſet in an equall ſpace of time. 2. But the parts of the Quadrants riſe and ſet unequally. 3. Thoſe ſignes that are equally diſtant from any of theſe points, have alſo equall aſcenſions: as Gemini and Cancer. 4. The Aſcenſion of a ſigne is alwayes equall to the Deſcenſion of the ſame. 5. Foure ſignes only riſe rightly, namely Gemini, Cancer, Sagittarius and Capricornus: and all the reſt obliquely.

Rules for the Aſtronomicall riſing in an Oblique Sphære.

IN an Oblique Sphære, the two halfes that begin at the two Æquinoctiall points, doe riſe together. 2. The parts of theſe halfes doe riſe unequally. 3. Thoſe ſignes that riſe rightly, deſcend Obliquely, and ſo contrarily. 4. The Aſcenſion of any ſigne is equall to the Deſcenſion of the ſame. 5. The Aſcenſionall Arches of the Northerne ſignes are leſſe then in a right ſphære, but in the Southerne ſignes they are greater. 6. The Aſcenſion of Oppoſite ſignes in an Oblique Sphære taken together, are equall to the Aſcenſion of the ſame in a right Sphære. 7. Thoſe ſignes that are equidiſtant from either of the Æquinoctiall points, have equall Aſcenſions, becauſe they decline equally from the Æquator.

CHAP: VIII.

How to finde out the Horizontall difference betwixt the Meridian and the Verticall circle of the Sunne, or any other Starre, (which they call the Azimuth,*) for any time or place aſſigned.*

HAving firſt obſerved the Altitude of the Sunne, or Starre that you deſire to know, ſet your *Globe* to the latitude of the place you are in: which done, turne it about, till the place of the Sun, or Starre which you have obſerved, be elevated ſo much above the Horizon, as the Altitude of the ſame you before obſerved. Now you ſhall find that you deſire, if you take the Quadrant of Altitude, and faſten it to the Verticall point of the place you are in, and ſo move it together with the place of the Sunne or Starre up and downe, untill it fall upon that which you have ſet downe in your inſtrument at your obſervation. Now in this ſituation of the Quadrant, that end of it that toucheth the Horizon, will ſhew the diſtance of the Verticall circle, in which you have obſerved the Sunne or Starre to be, from the Meridian. As for example.

In the Northerne latitude of 51. gr. on the 11th. of *March* after the old account, at what time the Sunne entreth into *Aries*, ſuppoſe the altitude of the Sunne before noone to be obſerved

ved to be thirtie gr. above the Horizon. And it is demanded, what is the *Azimuth*, or diſtance of the Sunne from the Meridian. Firſt therefore having ſet the *Globe* to the latitude of 51. gr. and faſtening the Quadrant of Altitude to the *Zenith*, I turne the *Globe* about, till I finde the firſt degree of *Aries* to be 30. gr. above the Horizon. And then the Quadrant of Altitude being alſo applied to the ſame degree of *Aries*, will ſhew upon the Horizon, the *Azimuth* of the Sunne, or diſtance of it from the Meridian, to bee about fortie five degrees.

Chap. IX.

How to find the houre of the day, as alſo the Amplitude of riſing and ſetting of the Sunne and Starres, for any time or latitude of place.

THe Sunne, we ſee, doth riſe and ſet at ſeverall ſeaſons of the yeare, in diverſe parts of the Horizon. But among the reſt it hath three more notable places of riſing and ſetting. The firſt whereof is in the Æquator, and this is called his Æquinoctiall riſing and ſetting. The ſecond is in the Summer Solſtice, when he is in the Tropique of *Cancer*: and the third is in the Winter Solſtice, when hee is in the Tropique of *Capricorne*. Now the Æquinoctiall riſing of the Sun is one and the ſame in every

Climate. For the Æquator alwayes cutteth the Horizon in the ſame points, which are alwaies juſt 90. gr. diſtant on each ſide from the Meridian. But the reſt are variable and change according to the diverſe inclination of the ſphære: and therefore the houres are unequall alſo.

PONT. *And here you are to underſtand, that the Amplitude of the Sunnes riſing and ſetting, is an Arch of the Horizon intercepted betwixt the Æquator, and the place of the riſing and ſetting of the Sun. And it is either Northerne or Southerne. The Northerne Amplitude, is when he ſets and riſeth on this ſide of the Æquator, toward the North Pole: and the Southerne when he ſets or riſeth on the contrary ſide. Now when the Sun is in the Æquator, he hath nce amplitude at all: but when hee is in the Solſticiall points, hee hath then the greateſt Amplitude of all: of which that in the Tropique of Cancer is called the Æſtivall, or Summer Solſticiall Amplitude; and the other the Brumall, or Winter Solſticiall Amplitude.*

And here it is to be noted, that in all places the Ortive Amplitude of any Starre is equall to the Occidentall Amplitude of the ſame. And likewiſe that two Starres being equally diſtant from the Æquator, the one Northward, and the other Southward, or both of them Northward, or Southward, have equall Amplitude of riſing and ſetting.

Now if you deſire to know the houre, or diſtance of time, betwixt the riſing and ſetting of the Sunne, when he is in either of the Solſtices,

ſtices, or in any other intermediate place, and that for any time, or latitude of place: you ſhall work thus. Firſt, ſet your *Globe* to the latitude of your place; then having found out the place of the Sunne, for the time aſſigned, apply the ſame to the Meridian, and withall you muſt ſet the point of the Houre-Index at the figure twelve in the Houre-circle. And having thus done, you muſt turne about the *Globe* toward the Eaſt part, till the place of the Sunne touch the Horizon: which done, you ſhall have the Amplitude of the Sunnes riſing alſo in the Æquator, which you muſt reckon, as we have ſaid, from the Eaſt point, or place of interſection betwixt the Æquator and Horizon. And then if you but turne the *Globe* about to the Weſt ſide of the Horizon, you ſhall in like manner have the houre of his ſetting, and Occidentall Amplitude.

And if at the ſame time, and for the ſame latitude of place, you deſire to know the houre and Amplitude of riſing and ſetting, or the greateſt elevation of any other Starre expreſſed in the *Globe*: you muſt turne about the *Globe*, (the Index remaining ſtill in the ſame poſition, and ſituation of the Index as before) till the ſaid Starre come to the Horizon, either on the Eaſt or Weſt: and ſo ſhall you plainely have the houre and latitude that the Starre riſeth or ſetteth in, in like manner as you had in the Sunne. And then if you apply the ſame to the Meridian, you ſhall alſo have the Meridian Altitude of the ſame Starre. An example

example of the Amplitude of the Suns rising and setting may be this.

When the Sunne enters into *Taurus*, (which in our time happens about the eleventh of *Aprill*, according to the *Julian* account) I desire to know, the houre and Amplitude of the Sunnes rising, for the Northerne latitude of fiftie one degrees. Now to finde out this, I set my *Globe* so, that the North Pole is elevated above the Horizon fiftie one degrees. Then I apply the first degree of *Taurus* to the Meridian, and the Houre-Index to the twelfth houre in the Houre-circle. Which done, I turne about the *Globe* toward the East, till that the first degree of *Taurus* touch the Horizon: and then I finde that this point toucheth the Horizon about the twentie fift degree Northward from the East point. Therefore I conclude that to bee the Amplitude of the Sunne for that day. In the meane time the Index strikes upon halfe an houre after foure: which I take to be the time of the Sunnes rising.

CHAP. X.

Of the threefold rising and setting of Stars.

BEsides the ordinary Emersion and Depression of the Starres in regard of the Horizon, by reason of the circumvolution of the Heavens: there is also observed a threefold rising and setting

ting of the Starres. The firſt of theſe is called in Latine, *Ortus Matutinus, ſive Coſmicus*, the Morning, or Coſmicall riſing: the ſecond *Veſpertinus, ſive Acronychus*, the Evening, or Acronychall: and the laſt *Heliachus, vel ſolaris*, Heliacall or Solar. The Coſmicall or morning riſing of a Starre is, when as it riſeth above the Horizon together with the Sunne. And the Coſmicall or morning ſetting of a Starre is, when it ſetteth at the Oppoſite part of heaven, when the Sunne riſeth. The Acronychall or Evening riſing of a Starre is, when it riſeth on the Oppoſite part, when the Sunne ſetteth. And the Acronychall ſetting of a Starre, is, when it ſetteth at the ſame time with the Sun. The Heliacall riſing of a Starre (which you may properly call the Emerſion of it) is, when a Starre that was hid before by the Sunne beames, beginneth now to have recovered it ſelfe out of the ſame, and to appeare. And ſo likewiſe the ſetting of ſuch a Starre (which may alſo fitly be called the Occultation of the ſame) is, when the Sunne by his owne proper motion overtaketh any Starre, ſo that by reaſon of the brightneſſe of his beames it can no more be ſeene.

POINT. *Concerning the riſing and ſetting of the Starres, which is conſidered in reſpect of the Horizon and Æquator, hath beene ſpoken already in the ſeventh* Chapter: *where we alſo ſhewed, that that kind of riſing and ſetting of the Starres was called Aſtronomicall. But in this place the riſing of the Starres is conſidered in relation only*

to

to the Horizon and Sunnes aſpect, but not of the Æquator; and therefore it is alſo commonly called, the Poëticall riſing and ſetting of the Starres.

Now as touching the laſt of theſe kinds many Authors are of opinion, that the fixed Stars of the firſt magnitude do begin to ſhew themſelves after their Emerſion out of the Sunne-beames, when as they are yet in the upper Hemiſphære, and the Sun is gone downe twelve degrees under the Horizon. But theſe of the ſecond magnitude require that the Suune is depreſſed 13. gr. and thoſe of the third, require foureteene; and of the fourth, fifteene; of the fifth, ſixteene; of the ſixth, ſeventeene, and the cloudy and obſcure Starres require eighteene degrees of the Suns depreſſion. But *Ptolomy* hath determined nothing at all in this caſe: and withall very rightly gives this admoniſhment, *lib.* 8. *cap. ult. Almag.* that it is a very hard matter to ſet downe any determination thereof. For as he there well noteth, by reaſon of the unequall diſpoſition of the aire, this diſtance alſo of the Sunne, for the Occultation and Emerſion of the Starres, muſt needs be unequall. And one thing more we have to encreaſe our ſuſpition of the incertainty of this received opinion, and that is, that *Vitellio* requireth nineteene degrees of the Suns depreſſion under the Horizon, before the Evening twilight be ended. Now that the obſcure and cloudy Starres ſhould appeare ever, before the twilight be downe, I ſhall very hardly be perſwaded

ſwaded to beleeve. Notwithſtanding, however the truth of the matter be, we will follow the common opinion.

Now therfore if you deſire to know at what time of the yeare any Starre riſeth or ſetteth in the moruing or the evening in any Climate whatſoever ; you may find it out thus. Firſt, ſet your Globe to the latitude of the place you are in, and then apply the Starre you enquire after, to the Eaſterne part of the Horizon : and you ſhall have that degree of the Eclipticke, with which the ſaid Starre riſeth Coſmically, and ſetteth Acronychally : and on the oppoſite ſide on the Weſt, the Horizon will ſhew the degree of the Eclipticke, with which the ſame Starre riſeth Acronychally, and ſetteth Coſmically. For the Coſmicall riſing, and Acronychall ſetting, and ſo likewiſe the Acronychall riſing, and Coſmicall ſettting of a Starre are all one ; according to thoſe old verſes.

Coſmicè deſcendit ſignum, quòd Acronychè ſurgit.
Chronychè deſcendit ſignum, quòd Coſmicè ſurgit.

But theſe things are to be explained more fully. For a Starre doth not alwayes riſe and ſet with the ſame degree of the Eclipticke. For the Southerne Starrs doe anticipate the degree with which they riſe, at their ſetting : but the Northerne Starres come after it ; that is, if the elevation be of the Articke Pole.

Other-

Otherwiſe it is quite contrary, if the South Pole be elevated. Now having found the degree of the Eclipticke with which the Starre you enquire after, doth riſe and ſet; if you ſeek for the ſame degree of the ſigne in the Horizon of your Globe, you ſhall preſently have the moneth and day expreſſed, wherein the Sunne commeth to the ſame degree and ſigne.

And as for the Heliacall riſing and ſetting of a Starre, you may find it thus. Having ſet your Globe to the latitude of your place, you muſt turne about the Starre propoſed to the Weſt ſide of the Horizon, and withall on the oppoſite Eaſt part obſerve what degree of the Eclipticke is elevated above the Horizon 12, 13, 14. or any other number of degrees, that the magnitude of your Starre ſhall require for diſtance from the Sunne. And when the Sun ſhall be in the Oppoſite degree to this, then that Starre will ſet Heliacally, that is to ſay, it will be quite taken out of our ſight by the brightneſſe of the Sunne-beames. Now if on the other ſide you apply the ſame Starre to the Eaſt, and find out the Oppoſite degree in the Eclipticke on the Weſt part, that is, the ſame number of degrees above the Horizon: when the Sunne commeth to this place, the ſame Starre will riſe Heliacally, or recover it ſelfe out of the Sunnes beames. And ſo if you but find the ſame degrees of the Eclipticke, among the Signes on the Horizon of your Globe, you have the Moneth and the day, when

when the Sunne will be in thoſe degrees. And the ſame alſo is the time of the Emerſion and Occultation of the Starre you enquire after. But we will here propoſe an example of the Occultation of ſome fixed Starre of the firſt magnitude: which done, the Emerſion of the ſame is alſo found by the contrary way of working.

And the Starre we propoſe, ſhall be that bright Starre in the mouth of the Great Dog, which is called *Sirius*: whoſe Occultation we deſire to know for the Latitude of 51. gr. Northward. Now this Starre, being of the firſt magnitude, beginnes to bee hid, when as it toucheth the Horizon in the upper Hemiſphære, and the Sunne is at the ſame time depreſſed under the Horizon but 12. degrees. If therefore you apply this Starre to the Weſt part of the Horizon (having firſt ſet your Globe to the latitude of 51. degrees) and on the Oppoſite Eaſt ſide, obſerve what degree of the Eclipticke is juſt 12. degrees above the Horizon (now this degree is very neare the 11. gr. of *Scorpius*) when the Sunne ſhall come to the Oppoſite degree in the Ecliptick, which is the 11. of *Taurus*, that Starre will ſet Heliacally, and be hid by the Sunne-beames. But the Sun comes to this degree of *Taurus* about the 22. of *Aprill*: therefore we conclude that the Dogge Starre ſets Heliacally about that time. And if you worke in the ſame manner, applying the Starre to the Eaſt part of the Horizon, you ſhall have the time of its

its Heliacall rising or Emersion out of the Suns beames.

Not unlike this is the manner of proceeding also in finding the beginning and ending of the twilights: of which we shall speake in the next Chapter.

PONT. *The use and benefit of this discourse concerning these kinds of rising and setting of the Starres, is principally seene, in reading of the ancient Authors and Poets, especially those that have written of Husbandry, and the severall seasons of the yeare. For so* Virgil. lib. 1. Georg. *makes mention of the Cosmicall rising of the Starres in these verses.*

Candidus auratis aperit cum cornibus annum.
Taurus, & adverso cadens Canis occidit astro.

Which is thus Englished by T. May.

When with his golden hornes bright Taurus *opes,*
The yeare: and downeward the crosse Dog-starre stoopes.

In which place hee meaneth to intimate the moneth of April, *when as the Sunne is in the signe* Taurus, *and riseth with it. And we have an example also of the Cosmicall setting in the same place, where he saith.*

At si triticeam in messem, robustáq; farra
Exercebis humum, solisque instabis aristis:
Antè tibi Eoæ Atlantides abscondantur,
Gnosiáque ardentis decedat stella coronæ,
Debita quàm sulcis cõmittas semina, quamq;

Invita

Invitæ properes anni ſpem credere terræ.
Multi ante occaſum Maiæ cæpere; ſed illos
Expectata ſeges vanis eluſit avenis.

Thus rendred by T. May.

But if thou plough to ſowe more ſolid graine,
A wheat or barley harveſt to obtaine:
Firſt let the morning Pleiades be ſet,
And Ariadne's ſhining Coronet,
Ere thou commit thy ſeed to ground, and there
Dare truſt the hope of all the following yeare.
Some that before the fall 'oth Pleiades
Began to ſowe, deceaved in the encreaſe,
Have reapt wilde oates for wheate, &c.

Where hee would have them to expect their ſowing time, till that the Altantides, *that is, the* Pleiades, *or ſeven Starres be hid in the Eaſt, that is, in the Morning by the approach of the Sunne, which is alſo called* Occaſus Coſmicus. *At which time alſo the bright Starre in the Northerne Crowne ſets in the Evening with the Sun, or Heliacally. And ſo the Poet by a twofold kind of ſetting of the Stars, deſcribes the* 28. *and* 29. *of* October.

An example of the Acronychall riſing you have in Ovid. lib. 1. de Ponto Eleg. 9. *where he deſcribeth the tedioufneſſe of his exile, from the Autumnall or Veſpertine riſing of the* Pleiades, *in theſe words.*

Vt careo vobis Scythicas detruſus in oras;
Quatuor Autumnos Plëias orta facit.

In Engliſh thus.

Since of your joyfull ſight cold Scythia me depriv'd
The riſing Pleiades foure Autumnes have reviv'd

And

And he also mentioneth the Acronychall setting, lib. 2. Fastor: *where speaking of the third of* February, *he doth it by this Periphrasis.*

Quem modo celatum stellis Delphina videbas,
Is fugiet visus nocte sequente tuos.

That is to say.

The Dolphin earst with Stars you saw bedight,
The next night vanisheth out of your sight.

An example of the Heliacall rising in February *you have in the same Author, in these words.*

Tertia nox veniet, custodem protenus ursæ,
Aspicies geminos exeruisse pedes.

Which may be Englished thus:

When now the third night comes, you shall perceive
Arctophylax will both his feet up heave.

And for the Heliacall setting, you had an instance above out of Virgil, Georg. 1.

---Et adverso cadens canis occidit astro.

In which place the Poet *speaketh of sowing millet and beanes in the spring time. To these we may also adde these severall kinds of Poeticall rising and setting of Starres expresst.*

Cosmicus est ortus, cum sol emergere quærit.
Ipsius oppositum lapsus, ad ima gerit.
Chronicus est lapsus, cum sol in vespere tabet.
Ipsius oppositum Chronicus ortus habet.
Heliacus signo datur ortus sole remoto.
Illius occasum proximitate noto.

CHAP.

CHAP. XI.

How to finde the beginning and end of the Twilight, *for any time and Latitude of place.*

THe *Twilight* is defined to bee a kind of imperfect light betwixt the Day and the Night, both after the ſetting, and before the riſing of the Sunne. Of which the firſt is called the *Evening Twilight*, and the other the *Morning*. Now the beginning of the one, and the ending of the other are perceived at the ſame equall ſpace of time from the riſing and ſetting of the Sun: notwithſtanding the continuance of each of them is ſometimes greater, and ſometimes leſſe. For in Summer the Twilights are much longer then in the Winter. The meaſure of them they commonly make to be, when as the Sunne is depreſſed 18. degrees under the Horizon. But, as *P. Nonius* rightly obſerveth, there cannot be any certaine Meaſure or Tearme aſſigned them, by reaſon of the various diſpoſition of the aire, and the elevation of the vapours that are exhaled out of the earth; which the ſame Author ſaith, he findes to be alſo diverſe, ſometimes higher, and ſomtimes lower, *Vitellio*, and *Alhazenus* before him, would have it to bee, when the Sun is depreſſed under the Horizon

nineteene degrees. But how ever the truth be, we shall follow the common received opinion herein. Now therefore if you desire to know upon these grounds here laid downe, at what houre the Twilight begins and endeth at any time or latitude of place; you must doe thus. First, set your *Globe* to the latitude of that place, and apply that degree of the Ecliptick, wherein the Sunne is at that time, to the Meridian, and withall direct the point of the Index to twelve in the Houre-circle: Then marking the degree of the Ecliptick, that is directly opposite to the place of the Sunne, turne about your *Globe*, till such time as the opposite degree of the Sunne be elevated eighteene gr. above the Horizon toward the West part of it: and forthwith the Index will shew in the Houre-circle the beginning of the Morning Twilight. And if you turne about your *Globe* in like manner to the East, you shall also have the houre when the Evening Twilight endeth.

PONT. *Our Northerne regions have their* παραυγασμὸς, *or Twilight, of above an houre long. But those Countries, where the* Tropickes *are very farre beneath their Horizon, have in a manner no* παραυγασμὸς, *no Twilight or breake of day. And therefore those that inhabite neare the Æquator, have not the beginning nor later part of the night enlightned at all, neither is there any appearance of light, before the Sunne bee risen. Whereas on the contrary side, those that have the* Tropicke *very neare their Horizon, must necessarily*

rily have Twilight almoſt all the night long in Summer. And therefore when the Romans *came into* Britaine, *and perceived that at the Summer Solſtice their nights were light almoſt all the night long: they did not account this Twilight to bee night, but ſaid,* Minimâ nocte contentos Britannos, *that the* Britaines *were contented with a very ſhort night.*

Now this παραυγασμὸς *as it is defined by* Ioſeph Scaliger *upon* Manilius, *is nothing elſe, but* περιστάσεως τινὰ παρίσωσις, *a kind of Antiperiſtaſis, or Circumſtipation (as we may call it) of the light: which can be none at all in thoſe places, where the* Tropicke *and Horizon are farre diſtant. For this* παραυγασμὸς, *as* Scaliger *in that place accurately obſerveth, is only found under thoſe ſignes, which are neare the Solſticiall point, as* Gemini *and* Cancer; *and that in thoſe Countries too, where the night is ſomewhat longer, then it is under the Pole of the Ecliptick: as for example, (to uſe* Scaligers *owne words) thoſe that have not the* Tropicke *for their Arcticke circle, nor where it toucheth the North point of the Horizon; with them the night is ſo long darke, as while the* Tropicke *commeth to ſtrike upon the North point of the Horizon. As we know it happeneth in* Scotland, *where our Countrimen that were Souldiers there, could ſee to play at dice all night long without any Candle, about the time that the daies were at the longeſt, Now the* Tropicke *is diſtant from the Horizon at* Edenburg 9. *gr.* 17. *m. or thereabout. And therefore ſo much is the diſtance betwixt the Sunne and their Horizon at midnight in*

the Summer Solstice: so that necessarily the rest of the night must bee Twilight, and of 6. houres, 23. minutes, which is the length of their night, not above 37. m. which is not much above halfe an houre, are quite darke: and all the rest of the night is light. Whence you may perceive the reason of the long continuance of the day in those regions, that have the Tropicke *neare bordering on their Horizon. And therefore the* Romans *being not well acquainted with this Antiperistasis of the light, thought that in those parts they had had scarce any night at all. And hence it necessarily followes, that by how much the* Tropicke *is more remote from the Horizon, by so much are the nights lesse enlightned: and those that inhabite neare the Æquinoctiall are so farre from having their day extended farther, either before the Sun rises, or after it sets, as that with them there is no appearance of light at all, before the Sun is up. And there is scarcely any Twilight or dawning of the Day at all, in those regions that lye within tenne degrees of the Æquinoctiall: for which there can be no other reason given, but only the distance betwixt the* Tropicke *and their Horizon. And if they have no Twilight in the Summer, how much lesse will there be any when the Sun is in the other* Tropicke. *So that we have no reason to give any credit to* Aloysius Cadamustus, *who when he had occasion to write of this argument, gave this to be the reason of it, because there are no mountaines there to hinder, but that the Sun may be seene at the instant of his rising. But this is a ridiculous reason, and not worthy a confutation. Thus* Scaliger.

Chap. XII.

How to find the length of the Artificiall Day or Night, or quantity of the Sunnes Parallel that remaines above the Horizon, and that is hid beneath it, for any Latitude of place and time aſsigned. As alſo to find the ſame of any other Starre.

THe Day we have already ſhewed to to be twofold; either Naturall, or Artificiall. The Naturall Day is defined by the whole revolution of the Æquator, with that portion alſo of the ſame that anſwereth to ſuch an Arch of the Eclipticke, which the Sunne paſſeth over in one day. Now the whole revolution of the Æquator (beſides that portion which anſwereth to the Sunnes proper motion) is divided into twentie foure equall parts, which they call equall houres: becauſe they are all of equall length, fifteene degrees of the Æquator riſing, and as many ſetting every houres ſpace. Now the beginning of this Day being diverſe, according to the diverſity of Countries, (ſome beginning it at Sun-ſet, as the *Athenians* and *Jewes*: ſome at midnight, as the *Ægyptians* and *Romanes*; others at Sunne-riſing, as the *Chaldeans*; or at Noone, as the *Umbrians*, and commonly our Aſtronomers doe at this day:) this being not a thing ſutable to our preſent

purpoſe, I ſhall not proceed any further in the explanation of the ſame.

The *Artificiall day* is defined to bee, that ſpace of time that the Sunne is in our upper Hemiſphære: to which is oppoſed the *Artificiall Night*, while the Sunne remaineth in the lower Hemiſphære. The *Artificiall day*, as alſo the Night, are divided each of them into 12. parts, which they call unequall houres: becauſe that according to the different ſeaſons of the yeare, they are greater or leſſe, and are never alwayes of the ſame length.

The length of the *Artificiall day* is thus found out. The *Globe* being ſet to the latitude of the place, you muſt find out the degree of the Ecliptick that the Sun is in at that time; and apply the ſame to the Meridian, and direct the Houre-Index to the number of 12. in the Circle. And then turning about the *Globe*, till that the place of the Sun touch the Horizon at the Eaſterne part, the Index will ſhew the houre in the Circle of the riſing of the Sun: and if you but turne it about againe to the Weſt, you ſhall in like manner have the houre of his ſetting, and ſo by this meanes find out the length of the *Artificiall day*. Now if you multiply the number of the houres by 15. (for ſo many degrees, (as we have already often ſaid) are allowed to one equall Æquinoctiall houre) you ſhall preſently have the number of degrees of the Suns Parallel that appeares above the Horizon: which if you ſubſtract out of 360. the remainder will be the quantity of that part

of

of the ſame Parallel that alwaies is hid under the Horizon. Or elſe you may proceed the contrary way, and firſt finde out the quantity of the Diurnall Arch, and afterward by the ſame, you may gather the number of the houres alſo. For the *Globe* being ſet to the latitude of the place, and the degree of the Eclipticke that the Sunne is in being knowne, you may finde out, in the manner now ſet downe, the difference of the Right and Oblique Aſcenſions of the ſame degree of the Eclipticke, for the latitude of that place. For this difference will be the halfe of that, wherein the *Artificiall day*, for that time and place, is either deficient, or exceeds the length of our Æquinoctiall day. And therefore you muſt adde it, when the daies are longer then the nights, (which is from the 11th. of *March*, to the 12th. of *September*:) but ſubſtract all other times of the yeare, when as the nights are longer then the dayes.

As for example. On the 12. day of *June*, according to the old account, the Sunne enters into *Cancer*: the Right Aſcenſion of which degree of the Eclipticke is 90. degrees. But if in the latitude of 52. gr. the firſt degree of *Cancer* bee applied to the Horizon, wee ſhall finde the Oblique Aſcenſion of it to bee fiftie ſixe gr. and about tenne m. So that the difference betwixt them is 33. gr. 50. m. which if you adde to ninetie gr. the halfe of the Æquinoctiall day, the length of the Artificiall day will then bee 123. gr. fiftie m.

and the whole Diurnall Arch 247. gr. 40. m. which if you divide by fifteene, the quotient will be ſixteene and almoſt an halfe: which is the number of houres in the Artificiall day on the twelfth of *June*, for the latitude of fiftie two degrees.

And by this meanes may you alſo finde out the quantity of the longeſt, or ſhorteſt, or any other intermediate day, together with the increaſe and decreaſe of the ſame, for any time or latitude of place.

Cleomedes would have the quantity of the dayes to increaſe and diminiſh after this manner: that the month immediately before and alſo after the Æquinoxe, the daies ſhold increaſe and decreaſe the fourth part of the whole difference betwixt the length of the longeſt and the ſhorteſt dayes of the whole yeare: and the ſecond moneth they ſhould differ a ſixth part; and the third a twelfth part: that is, if the whole difference betwixt the longeſt and the ſhorteſt day bee ſixe houres. So that the moneth going immediately before, and after the Æquinoxe, the dayes increaſe and decreaſe an houre and an halfe, that is to ſay, the fourth part of 6. houres: the ſecond month an whole houre; and the third month halfe an houre. But ſuppoſe we this to be exactly agreeable to ſome certaine determinate latitude; yet it is not generally ſo in all places. For according to the diverſe Inclination of the Sphære, the daies alſo are obſerved to increaſe and decreaſe diverſly. For ſeeing that the Parallels in every

ſeverall

ſeverall latitude are cut by the Æquator in a different manner, it muſt needs follow, that the proportion of the increaſe and decreaſe of the dayes muſt be alſo different.

I ſhall not here need to ſet downe the manner, how to find the apparent Arch of the Parallel of any Star: ſeeing that it is found out in the ſame manner, as the Diurnall Arch of the Sunnes Parallel is.

CHAP. XIII.

How to finde out the houre of the Day and Night, both equall and unequall, for any time and latitude of place.

IF you deſire to finde out the equall houre of the Day, firſt ſet your *Globe* to the latitude of the place you are in: and alſo obſerve the latitude of the Sunne Which done, apply the place of the Sunne to the Meridian, and ſet the Index to the twelfth houre in the Circle; and then turne about the *Globe* either to the Eaſt, or Weſt, as your obſervation ſhall require, untill that the place of the Sunne be elevated ſo many degrees above the Horizon, as ſhall agree with your obſervation; as hath beene already ſhewed, in declaring how to find the *Azimuth*. And the *Globe* ſtanding in this ſituation, the Index will point out in the Houre-circle the houre of the day, wherein your obſervation was made. After the ſame

ſame manner alſo you may finde the houre of the night, by obſerving the Altitude of any knowne Starre, that is expreſt in the *Globe*. For the Index muſt ſtand ſtill, as it did before, when it was fitted to the place of the Sunne: and the *Globe* muſt bee turned about, till the Starre be obſerved to have the ſame Elevation above the Horizon of the *Globe*, as it had in the Heavens, and then the Index will ſhew the houre of the Night.

Now the manner how to find out the unequall houre of the day, is this. Firſt you are to find out, as we have already ſhewed, the quantity or number of the houres of the *Artificiall day*, and alſo the equall houre of the ſame: whence by the rule of proportion, you may alſo come to the knowledge of the unequall houre.

PONT. *The unequall houres doe anſwer to the* Artificiall day, *which, (as you have heard before,) is defined to be the ſpace of time that the Sunne remaines in the upper Hemiſphære: to which is oppoſed the* Artificiall night, *comprehending all that time, while the Sun is hid from us. Which ſpace of time, ſeeing that it is alwayes divided into* 12. *parts, (which they call unequall houres:) the day it ſelfe being at diverſe ſeaſons of the yeare of different length, the houres it containes muſt alſo be unequall. So likewiſe on the other ſide, the equall houres doe agree to the Naturall day, which is defined by the whole and perfect revolution of the Æquator: And this alſo is divided into* 24. *equall parts, which are therefore called equall houres, becauſe*

cauſe they are alwayes of equall length, fifteene degrees of the Æquator riſing and ſetting every houre. For the whole Æquator being divided into 24. parts, there are contained in the revolution of it 15. parts of time, which is the meaſure of an houre: ſo that an equall houre is the 24th. part of the whole Æquinoctiall circle.

In the latitude of 49. degrees, the longeſt day containeth 16. houres. Now therefore when it is 10. of the clocke before Noone, or the ſixth houre after Sun-riſing on this day, I deſire to know, what unequall houre of the day it is. I therefore diſpoſe my proportionall tearmes thus, 16. give 6. therefore 12. (which is the number of equall houres in every day or night) give 4. and an halfe.

And if wee deſire to know, how many degrees of the Æquator doe anſwer to one unequall houre; we may doe it thus: namely by dividing the whole number of degrees of the Diurnall Arch by 12. As if the *Artificiall day* bee 16. equall houres in length, then the Arch of the Diurnall Parallel will be 240. degrees. Which if we divide by 12. the quotient, which is 20. will ſhew the number of degrees in the Æquator that anſwer to one unequall houre. The like method alſo is to be obſerved, in finding out the length of the unequall houre of the Night.

CHAP.

CHAP. XIV.

To finde out the Longitude, Latitude, and Declination of any fixed Starre, as it is expreſſed in the Globe.

THe Longitude of a Starre, is an Arch of Eclipticke intercepted betwixt two of the greater Circles, which are drawne thorough the Poles of the Eclipticke, the one of which paſſeth through the interſection of the Æquator and Eclipticke, and the other through the Center of the Starre.

The Latitude of a Starre, is the diſtance of it from the Eclipticke; which is alſo to bee reckoned in that circle which paſſeth through the Center thereof.

Now if you deſire to find out either of theſe, you muſt take the Quadrant of altitude, or any other Quadrant of a Circle, that is but exactly divided into 90. parts: and lay one end of it on either Pole of the Eclipticke, either Northerne or Southerne, as the latitude of the Star ſhall require. Then let it paſſe through the Center of the Starre to the very Eclipticke, and there the other end will ſhew the degree of longitude of the ſame, which you muſt reckon fom the beginning of *Aries:* and ſo that portion of the Quadrant that is contained betwixt the Starre it ſelfe and the Eclipticke,

ticke, will alſo ſhew the latitude of the Starre.

POINT. *The manner how to finde the longitude and latitude of Starres, may bee ſhewed by this example. Firſt, let us propoſe the head of* Meduſa, *which is found in the tables to bee in the twentie one gr.* 8. *and it hath in Northerne latitude twentie three degrees. Now therefore in the ſuperficies of the* Globe *wee muſt looke for the ſigne* 8. *and reckon* 21. *gr. from the beginning of the ſame on the Eclipticke: And the circle that ſhall be drawen from the Pole of the Eclipticke through this degree, ſhall bee called the circle of longitude of the head of* Meduſa. *After this reckon the latitude of the Starre alſo in the ſame circle among the Parallels of latitude, beginning from the Eclipticke, and ſo forward toward the Articke Pole, (becauſe the latitude of it is Northerne,) untill you have accounted* 23. *gr. which is the number of the degrees of latitude, and ſheweth the place of that Starre.*

Now becauſe that all the circles of longitudes and latitudes neither are, nor indeed can conveniently bee expreſſed on the Globe: *therefore the Quadrant of altitude is to ſerve in ſtead of the ſame, for the finding out of the longitudes and ſituations of the Starres that are ſet in the* Globe: *and that after this manner. Let us take our former example of* Meduſa's *head: the latitude of which being Northerne, I apply the end of the Quadrant to the North Pole of the Zodiaque: (otherwiſe had it beene Southerne, it muſt have been fitted to the Southerne Pole:) which done, I ſeeke*

in

in the Ecliptick for the 21. gr. of Taurus, *which is the longitude of the Starre; and having found it, I lay the other end of my Quadrant over it. For by this meanes the Quadrant shall supply the office of the circle of longitude of* Medusa's *head. Now therefore if I reckon 23. degrees on the said Quadrant, beginning from the Ecliptick, I shall have the true situation of this Starre in the* Globe.

In like manner may we finde, by a Globe *that hath the Starres described on it, the longitude and latitude of any Starre in the heavens. For if we fit the Quadrant to the Notherne Pole of the* Zodiaque *(if the Starre have Northerne latitude) and then let it passe through the center of any Starre: the degree of the Ecliptick that the other end of it shall point out, will be the longitude of the said Starre: and the degrees that are contained betwixt the Ecliptick and the Starre, will shew you the latitude of the same. As for example, if the Quadrant being first applied to the Northerne Pole of the* Zodiaque, *be afterward laid along over the bright Star in the* Crowne; *the other end of it will fall on the 6. gr.* ♏. *which is the longitude of this Starre. And then if you reckon the number of degrees betwixt the Ecliptick and the same Starre, you shall finde them to bee* $44\frac{1}{2}$. *gr. which is the Northerne latitude of the same.*

The Declination of a Starre, is the distance of it from the Æquator: which distance must bee reckoned on a greater circle, passing through the Poles of the Æquator. And there-

therefore if you but apply any Starre to the Meridian, you ſhall preſently have the Declination of it, if you account the degrees and minutes of the Meridian (if there be any) that are contained betwixt the Center of the Starre and the Æquator.

PONT. *The Declination of Starres, as alſo their Right Aſcenſion, may bee knowne by the* Globe *in this manner. The Starre propoſed muſt be applied to the Meridian, and forthwith the ſame Meridian will diſcover, among the degrees of the Æquator, the Right Aſcenſion of the ſame: and it will alſo give you the Declination, if you reckon upon it the number of degrees that are comprehended betwixt the Æquinoctiall and the Starre propoſed. And for an example of this, let us propoſe the Great Dogge, whoſe Right Aſcenſion and Declination wee deſire to know. Firſt, therefore we ſet the Starre it ſelfe directly under the Meridian, and find the Meridian to cut the Æquinoctiall at* 97. *gr.* 15. *m. And this is the right Aſcenſion of this Star. And then reckoning the number of the degrees comprehended betwixt it and the Æquinoctiall Southward: we find them to be* 16. *degrees, which wee conclude to bee the Southerne latitude of this Starre.*

The ſame alſo may be demonſtrated by the Sun. For when the Sunne is in the 3. *gr. of* Gemini, *he is carried under the Meridian, which croſſeth the Æquinoctiall about the* 63. *gr. reckoning from the firſt degree of* Aries *in the Æquator. And this is the Aſcenſion of the Sunne when he is in the* 3. *degree of* Gemini. *Now the number of the degrees*

degrees that are comprehended betwixt the place of the Sun and the Æquator, being reckoned in the Meridian, are found to be 21. *which is also the Suns Declination, and that Northward, because it falleth among the Northerne signes.*

The same may be performed also after another manner, as thus for example. The right Ascension of the bright Star in the Crowne is found in the Astronomicall Tables to be 275. *gr.* 31. *m. and the Declination of it Northward* 38. *gr.* 26. *minutes. First therefore I reckon the degrees of Right Ascension in the Æquinoctiall, beginning at the first degree of* Aries; *and having found the degree, I apply it to the Meridian in which I afterward reckon the Declination assigned, beginning from Æquinoctiall, and proceeding toward the Arcticke Pole, if the Declination of the Starre bee Northerne; if otherwise, toward the Antarctique.*

A Table representing the Longitude, Latitude, Right Ascension, and declination of some certaine Notable STARRES.

The names of the Stars.		Longitude. Deg.	Min.	Latitude D.	M.	Nor. Sou.	Right Ascension. Deg.	Min.	Declinat. Deg.	Min.	Nor. Sou.
The first Star in the Rams Horne.	♈	28	0	7	20	Nor.	20	0	18	0	Nor.
The 1. horse in the waine	♍	3	30	53	30	Nor.	188	10	57	27	Nor.
The 3. horse.	♍	21	10	54	0	Nor.	202	24	51	5	Nor.
The head of the Dragon.	♌	21	0	75	30	Nor.	226	8	52	8	Nor.
Bootes left shoulder.	♎	11	0	49	0	Nor.	212	50	40	0	Nor.
Arcturus.	♎	18	20	31	30	Nor.	109	17	21	12	Nor.
The bright Starre in the Crowne.	♏	6	0	44	30	Nor.	229	0	38	25	Nor.
The head of Hercules.	♐	9	0	37	30	Nor.	252	51	15	16	Nor.
The bright Starre of Lybra.	♑	8	40	62	0	Nor.	275	31	38	16	Nor.
The Taile of the Swanne.	♓	0	30	60	0	Nor.	307	30	44	15	Nor.
The Swannes bill.	♑	25	50	49	20	Nor.	288	40	27	32	Nor.
Cassiopeia's breast.	♉	2	10	46	45	Nor.	4	23	54	26	Nor.
The Goat.	♊	16	20	22	30	Nor.	71	58	45	7	Nor.
The right side of Perseus.	♉	25	0	30	0	Nor.	43	0	48	0	Nor.
Medusa's head.	♉	28	0	23	0	Nor.	41	0	30	0	Nor.

The names of the Stars.		Longitude. Deg.	Min.	Latitude D.	M.	Nor. Sou.	Right Ascension. Deg.	Min.	Declinat. Deg.	Min.	Nor. Sou.
Andromedas head.	♈	16	40	24	30	Nor.	357	0	27	0	Nor.
The Star in the end of Pegasus wing.	♒	9	0	34	15	Nor.	358	20	13	0	Nor.
Pegasus shoulder.	♒	15	0	41	10	Nor.	341	11	13	0	Nor.
The Eagle.	♑	25	10	29	10	Nor.	292	40	7	57	Nor.
The head of the Serpent-bearer.	♊	16	10	38	0	Nor.	288	32	13	5	Nor.
The buls eye	♉	4	0	5	10	Nor.	63	0	15	54	Nor.
Castor	♋	14	40	9	40	Nor.	107	0	32	30	Nor.
Pollux.	♋	18	0	6	15	Ner.	110	20	28	30	Nor.
The Lions Heart.	♌	23	50	0	10	Nor.	146	33	13	45	Nor.
Spica Virginis.	♍	18	0	2	0	Sou.	195	46	8	55	Sou.
The South ballance of Libra.	♎	9	20	0	40	Sou.	217	8	14	0	Sou.
The heart of the Scorpion	♏	4	34	4	38	Sou.	241	41	25	30	Sou.
The taile of Capricorne.	♑	20	0	4	20	Sou.	319	18	18	5	Sou.
Aquarius Thigh.	♒	3	0	7	30	Sou	337	47	17	24	Sou.
The Whales Taile.	♓	17	0	20	20	Sou.	5	42	19	46	Sou.
The Whales Nosthrils.	♉	9	0	7	45	Sou.	40	32	2	47	Sou.
The Right shoulder of Orion.	♊	3	20	17	0	Sou.	83	34	6	16	Sou.
The left foot of Orion.	♊	10	30	31	30	Sou.	73	15	9	10	Sou.
The lesser Dog.	♋	20	30	16	10	Sou.	109	45	5	53	Sou.
The great Dog.	♋	9	0	9	0	Sou.	97	15	15	56	Sou.

CHAP. XV.

To finde the variation of the Compaſſe, for any Latitude of place.

THat the Needle touched with the Loadſtone, doth decline in diverſe places from the Interſection of the Meridian and Horizon, is a thing moſt certaine, and confirmed by daily experience. Neither is this a meere forgery of Mariners, intended by them for a cloake of their own errours: as *P. De Medina*, Grand Pilot to the King of *Spaine* was of opinion. Neither yet doth it ſo come to paſſe, by reaſon that the vertue of the Magnet by long uſe and exerciſe is weakened; as *P. Nonius* conceived: or elſe becauſe it was not originally endued with ſufficient vertue: as ſome others coldly conjecture: but this motion proceeds from its owne naturall inclination. The cauſe of this deflexion, although hitherto in vaine ſought after by many, hath yet beene found by none. In this, as in all other of Natures hidden and abſtruſe myſteries, we are quite blind. There have beene ſome that have endeavoured to preſcribe ſome certaine Canons or rule for this Deflexion, as if it had beene regular and governed by ſome certaine order; but all in vaine. For that it is inordinate and irregular, is teſtified by daily experience, not only ſuch as is taken from the dull conjecture

of the common sort of Mariners, which ofttimes falls farre wide of the truth: but from the farre more accurate observations of skilfull Navigatours.

At the Isles, which they call *Azores*, it declineth not at all from the true Meridian: as the common opinion of Mariners is. And I dare bee bold to affirme, that at those more Westerne Islands also, it varieth very little or nothing at all. But if you saile Eastward from those Islands, you shall observe that point of the Needle that respects the North, to incline somewhat toward the East. At *Antwerpe* in *Brabant* it varieth about nine degrees: and neare *London* it declineth from the true Meridian above eleven degrees. And if you saile Westward from those Islands, the Needle also will incline toward the West. About the Sea Coasts of *America*, in the latitude of thirtie five, or thirtie sixe degrees, it declineth above eleven *gr.* from the true Meridian. Beyond the Æquator it happens cleane otherwise. Neare the outwardmost Promontory of *Brasile* looking Eastward, which is commonly called, *C. Frio*, it varieth from the true Meridian above twelve degrees. Within the most Eastward parts of the Straites of *Magellane* it declineth five or sixe *gr.* And if you saile from that Promontory, we now spoke of, toward *Africke* Eastward, the variation still encreaseth, as farre as to 17. or 18. degrees: which (as farre as

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we can conjecture) happens in a Meridian not farre from that which paſſeth through the *Azores*. From thence the deflexion decreaſeth to nine or tenne *gr.* which happeneth neare the Iſle of Saint *Helen*, bearing ſomewhat toward the Weſt. And from hence they ſay it decreaſeth, till you are paſt the *Cape of good hope*, where they will have it to lye in the juſt ſituation of the true Meridian, neare to a certaine River, which for this cauſe is called by the *Portugals*, *Rio de las Agulias*. And all this deviation is toward the Eaſt.

All this wee have had certaine proofe and experience of, and that by as accurate obſervations as thoſe inſtruments, which are uſed in Navigation, would afford, and the ſame examined and calculated according to the doctrine of Spharicall Triangles. So that we have juſt cauſe to ſuſpect the truth of many of theſe traditions, which are commonly delivered, concerning the deflexion of the Needle. And namely whereas they report, that under that Meridian which paſſeth through the *Azores*, it exactly reſpects the true Meridian; and that about the Sea coaſts of *Braſilia* the North point of the Needle declineth toward the Weſt, (as ſome affirme) we have found this to bee falſe. And whereas they report that at New-found land it declineth toward the Weſt above 22. degrees: we very much ſuſpect the truth hereof: becauſe that this ſeemes not at al to agree with the obſervation we have made

concerning the variation about 11. degrees, neare upon the coaſts of *America*: of the truth of which I am ſo confident, as of nothing more. It therefore appeares to be an idle fancy of theirs, who look to find ſome certaine point which the Needle ſhould alwayes reſpect; and that either on the earth, (as namely ſome certaine Magneticall mountaines, not far diſtant from the Arcticke Pole,) or elſe in the Heavens, as (namely the taile of the little Beare, as *Cardan* thought:) or elſe that it is ſituate in that very Meridian that paſſeth through the *Azores*, and about ſixteene degrees and an halfe beyond the North Pole: as *Mercator* would have it. And therefore there is no heed to be taken to them neither, who conceive that there might be ſome certaine way found out of calculating the longitudes of places by means of this deflexion of the Needle: which I could wiſh they were able to performe: and indeed it might bee done, were there any certaine point that it ſhould alwayes reſpect.

But to leave this diſcourſe, let us now ſee, how the quantity of this declination of the Needle may bee found out by the uſe of the *Globe*, for any place of knowne latitude. And firſt you muſt provide you of ſome inſtrument, by which you may obſerve the diſtance of the Suns *Azimuth* from the ſituation of a Needle, Our Mariners commonly uſe a Nautical Compaſſe, which is divided into three hundred ſixtie degrees, having a thread placed croſſe-

wiſe

wiſe over the center of the Inſtrument to caſt the ſhadowes of the Sunne upon the center of the ſame. This inſtrument is called by our Mariners, the Compaſſe of variation: and this ſeemeth to bee a very convenient inſtrument for the ſame uſe. But yet I could wiſh that it were made with ſome more care and accurateneſſe, then commonly it is.

With this, or the like inſtrument, you muſt obſerve the diſtance of the Sunnes *Azimuth*, for any time or place, from the projection of the Magneticall Needle. Now we have before ſhewed, how to find out, how much the verticall circle of the Sunne is diſtant from the true Meridian. And the difference that there is betwixt the diſtance of the Sunne from the true Meridian, & from the ſituation of the Needle, is the variation of the Compaſſe. Beſides, we have already ſhewed, how the Amplitude of the riſing and ſetting of the Sunne may bee found. If therefore by the helpe of this, or the like inſtrument, it be obſerved, (as wee have ſaid) how many degrees the Sunne riſeth or ſetteth from thoſe points in the Compaſſe, that anſwer to the Eaſt or Weſt: you ſhall in like manner have the deviation of the Needle from the true Meridian, if it have any at all.

PONT. *At the end of this Chapter, I thinke it not amiſſe to ſet downe, that which* Ioſeph Scaliger, *ſometime upon occaſion offered, wrote unto* David Rivaldus, *concerning the declination of the Magneticall Needle from the true Meridian. This Epiſtle of his is extant among thoſe*

Epistles that were set forth at Paris with some other of his workes, Anno 1610. And because that there is something in the same that concernes the controversie of the Præcession of the Æquinoctiall points; I will set downe very neare the whole Epistle: and thus it is. Literas tuas cum maxima voluptate, &c.

Your Letters I have received, and read with very great satisfaction and delight: wherein I perceived two things chiefely to bee insisted upon: Which were, the Declination of the Magneticall Needle; and the Præcession of the Æquinoctiall points. In my former Letters I made mention indeed of the same, but with an intention rather to discover the opinion of others, then to proclaime mine owne. For I onely made a bare proposall of the matter, and no dogmaticall Position: that so, if the said declination bee to bee examined by the Meridians, and the Meridians, according to my Hypothesis, be moveable; that then our Astronomers and Navigators should see, whether or no, there might not some cause and reason of this so manifest disagreement bee discovered, out of this Essay of mine. For I would not have proposed it only, had I beene certainely assured of it: but would rather have endeavoured to make it appeare by demonstration. Whether therefore that be the cause of it, which I desire should be searched for out of my Hypothesis; or whether it be some other, it shall be all one to me. But the investigation of the Meridians is not sufficient for this matter. For

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we muſt firſt diſpute concerning the nature of the Magnet, whether or no it bee the property of it, alwayes to reſpect the North point: and if ſo, yet ſeeing that it declines from the Tearme propoſed ſo many degrees, wee are next to enquire, whence this Variation proceeds: which certainely can be aſſigned to no other thing, then to the Meridians. But that we may not urge this queſtion any farther: we muſt conſult with thoſe Authors that have written of the Magnet; and eſpecially with William Gilbert *of* Colcheſter, *a Philoſopher and Practitioner of Phyſicke in* London, *who about three yeares ſince put forth three large bookes of the ſame ſubject: wherein he hath diſcovered to me his owne learning rather, then the nature of the Magnet. For now I am more in doubt, then before. The other part of your Letter is, concerning the Præceſſion of the Æquinoctiall points. It was obſerved firſt of all by* Hipparchus, *out of the obſervations of the fixed Starres of* Ariſtarchus Samius, Conon, *and* Timocharcis, *that the Æquinoctiall points were gone forward into the præcedent parts; becauſe that hee had found that the foure points (Æquinoctiall and Solſticiall) were farther off from the Starres aſſigned for the ſame, then they were in the time of thoſe Aſtronomers. Which when hee ſaw, hee doubted not forthwith to affirme, that the Æquinoctial points were immoveable, and that the Sphære of the fixed Stars was gone backe into the ſucceeding parts. And hee did not perſwade himſelfe only to this, but even* Ptolomy *alſo; and* Ptolomy *all that came after him.*

ſo

So great is the power of Prejudicate Authority. And he also rectified the Globe, *and made the taile of the little* Beare *to bee distant from the Pole twelve* gr. *twentie foure* m. *choosing rather to beleeve it to bee so, then to consult with the Starres to see whether it were so indeed, or no. Which thing I cannot sufficiently wonder at in him; seeing that not onely in his time, but also two hundred and eighteene yeares before him, the taile of the lesser* Beare *was no farther from the Pole of the world, then it is at this day: as* Eudoxus *observed. Which I have most plainely demonstrated in my booke of the* Præcession of the Æquinoctiall points. *Besides,* Eratosthenes *also, who wrote one hundred twenty eight yeares after* Eudoxus, *affirmeth the same of the same Starre: and so did those that wrote in* Augustus *his time. If therefore two hundred and eighteene yeares before* Hipparchus *time that Starre was where it is now; how then can that position of* Hipparchus *stand, who placed it* 12. gr. 24. m. *of the Pole of the world? For if the Sphære of the fixed Starres laid more backeward into the succeeding parts, (as hee would have it) and that in his time the Taile of the Cynosure was* 12. gr. 24. m. *distant from the Pole: it necessarily followes, that in* Eudoxus *time it must have beene farther distant from the Pole, by* 13. *or* 14. gr. *For this is the propation of degrees required for that motion. But it was then no farther distant, then it is at this day: and therefore* Hipparchus *hath abused both himselfe, and all that have come after him. And*

indeed

indeed I my ſelfe have made a collection out of him, of all the riſings and ſettings of the Starres: which no man ſhall ever be able to underſtand, except he firſt make ſuch a Globe, wherein the taile of the Cynoſure ſhall be 12. gr. 24. m. diſtant from the Pole. Which thing when I imparted to that great Aſtronomer Tycho Brahe, he was amuſed and wondred very much at the novelty and ſtrangeneſſe of the thing: and indeed not without cauſe. For I did not ſpeake a word to him of the conſtruction of Hipparchus his Globe, and the diſtance of the Cynoſure from the Pole of it. And therefore we plainely ſee, that for as much as this Starre keepes the ſame diſtance from the Pole at this day, that it did 1967. yeares ſince, there is no motion at all of the eighth Sphære into the ſucceeding parts, but of the Æquinoctiall points into the precedent. For of the motion there is no doubt at all to be made: for at this time the Æquinoxe falleth before the firſt Starre in Aries above 28. gr. which notwithſtanding in Eudoxus his time happened at the very Starre.

But now whether the Starre hath left the Sun behind it, or the Sunne the Starre, is the principall matter in queſtion. For it muſt needes bee that one of them muſt ſtand ſtill, and the other move: but wee have already ſhewed that the Starres are immoveable: and therefore the Sun, and Æquinoctiall points are moveable. And indeed they have manifeſtly gone forward ſince Eudoxs time 28. degrees.

This Copernicus (that great Scholler, and ſecond Ptolomy of our age) perceived, when he

ſpake

spake these words. Vos putatis, &c. *You thinke (saith hee) that the eighth Sphære moveth into the consequent parts: but consider whether the Æquinoctiall points doe not rather move forward. Whence it appeares, that this never sufficiently commended man concluded, that there was a Præcession of the Æquinoctiall points, and not a motion of the eighth Sphære into the subsequent parts. For one of these being granted, the other must necessarily bee taken away: for if the eighth Sphære doth not move backward, the Æquinoctiall points must necessarily move forward. And therefore herein* Copernicus *conjectured aright. But he omitted the chiefest matter of all, either because perhaps hee perceived it not, or else despaired of ever being able to demonstrate it. For seeing that the Æquinoctiall points are Moveable, it must needs follow, that a greater Circle described by the same must bee Moveable also, by the twentie* Sphæric. Element. *And if the Circle be Moveable, the Pole must also be Moveable. And therefore the Pole of the Æquinoctiall is not the same with the Pole of the world: for this is Immoveable, but the other Moveable: and so consequently all the greater Circles passing through these Poles, which are the Meridians, are also Moveable. So that Sunne-dials, and all Sciotericall instruments, that are placed upon a Meridian line, after some certaine tearme of years, must necessarily be defective: because the line it selfe is removed from its former situation. Of which variablenesse wee have observed notable*

arguments

arguments in monuments of Antiquity. Theſe things it did concerne Copernicus *either to have ſeene, or demonſtrated, who was the firſt man that ever rejected that fabulous and ridiculous motion of the eighth Sphære, and withall propoſed this opinion of the Præceſſion of the Æquinoctiall points: Who, had hee but ſeene thoſe things, which wee have obſerved hiſtorically out of the writings of the Ancient Aſtronomers, ſo great was the ingenuity of the man, that hee would have inſtantly conſented, and demonſtrated the matter Mathematically; which certainely is no hard matter to doe. For is there any man ſo void of all reaſon and judgement, as having granted the Æquinoctiall points to bee Moveable, to deny that a great Circle deſcribed by the ſame, muſt neceſſarily be Moveable alſo: and if ſo, that the Poles are alſo Moveable: and againe this being granted, that the Meridians are ſo too? He that ſhall deny this, I cannot ſee, what it hath profited him to have ſtudied the Mathematickes.*

But you will Obiect, that the Meridians are not changed, becauſe they paſſe through the Poles of the world, which are Immutable.

But then you have forgotten our Hypotheſis, which is, that the Poles of the Æquinoctiall are not the ſame with the Poles of the world. For theſe are Immutable, but thoſe other Mutable. And therfore we ſee the neceſſity of this Argument; and withall that theſe things being ſo, we are yet very farre

farre to seeke in many things necessary for the situation and construction of the Sphere. For by this reckoning it followeth necessarily, that the Æquinoctiall circle should not bee described directly Parallel to the Pole of the world: and many other things of this nature, which might hence be concluded, I might willingly omit, because I speake to a Mathematician, who might better teach in these things. Wherefore I thinke I may boldly say, that none can be so impudent as to deny these things which are so manifest, as that we can prove them not only Historically, but also Apodictically, by certaine demonstration. And it behoves you to see and examine more narrowly whatsoever hath beene written by Mathematicians concerning this matter. For there is now no place left of denyall, but rather to see, how these things may be better demonstrated, and this done, the construction and position of the Sphære corrected. But I doe not speake this to the common sort of Astrologers, who never have read any thing but the Theories of the Planets, and never so much as saw any of the Ancient Writers: unto whom, although they should perhaps have recourse, they could not understand.

Now as concerning the motion of Trepidation, *it is long since exploded: and for* Copernicus *his motion of* Libration, *which is also a very vaine conceit, and I shall speake more of it hereafter, and shew whence this so idle a dreame should possesse so worthy a man: for it differeth not much from that impoſture of* Trepidation. *And as the truth hath at length got place, and*

removed

removed that fabulous motion of Trepidation: ſo wee doubt not but neceſſity will at the laſt ſend after it this motion of the eighth Sphære alſo.

This therefore is the ſumme of our anſwer: that we deſire, that the skilfull Artiſts would conſider, whether the knowledge of the variation of the Magneticall Needle may be illuſtrated by thoſe things which we have delivered concerning the Mutability of the Meridians: That there is no motion of the eighth Sphære into the conſequent parts: That we are the firſt that have demonſtrated the ſame: and that from thence muſt neceſſarily follow the Preceſſion of the Æquinoctiall points. And this being granted, that then the Æquinoctiall points, Æquinoctiall circles, and their Poles, and Meridians paſſing through them are alſo moveable: and their Poles alſo different from the Poles of the world. And that the ſituation of Sunne Dials doth vary after ſome tearme of yeares: and that we are the firſt that obſerved the hiſtory of this notable peece of Antiquity; which alſo may be demonſtrated out of the Mathematickes. This is my opinion, which I will ever defend. But doe you conſider better of it: and in the meane time Farewell. Lug. Bat. 16. Kal. Mai. An. 1604.

And this is Scaligers Epiſtle, in which whereas he ſpeaketh of three bookes of the Magnet, written by W. Gilbert, it ſeemes to be a ſlip of his memory: for the ſame Author wrote, not three, but ſixe bookes de Magnete, which were printed at London by Peter Short, An. 1600.

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the fourth and fifth bookes whereof doe especially handle the doctrine of the variation of the Compasse. And whereas he addeth, that himselfe had plainely demonstrated in a certaine booke of his, that the Taile of the Cinosure had the same situation anciently, that it hath at this day; he meaneth that booke which beareth title, Diatriba de Æquinoctiorum Anticipatione, *and was printed at* Paris, An. 1613. *Which booke I understand since, that* Iohannes Maginus *a* Paduan, *and professour of the Mathematiques in* Bononia, *hath undertaken to confute: as appeares by the Catalogue of bookes in the yeare* 1617. *where there is mention made of the same Confutation printed at* Rome, *by* Andrew Brugioti; *and at* Colen, *by* Antony Hierat, *in quarto. In which booke the Author takes upon him to impugne certaine new Tenets, concerning the Polar Starre, and the mutation of the Æquinoctiall points, and immobility of the fixed Starres: with diverse Astronomicall matters, which the title promiseth: notwithstanding it hath not yet beene my good hap, though I have made very diligent enquiry, to meet with any of these bookes.*

Chap.

Chap. XVI.

How to make a Sunne Diall by the Globe, *for any Latitude of place.*

WE do not here promiſe the whole Art of Dialling: as being a matter too prolixe to be handled in this place, and not ſo properly concerning our preſent buſineſſe in hand. And therefore it ſhall ſuffice us to have touched lightly, and as it were, pointed out only ſome few grounds of this Art: being ſuch as may very eaſily bee underſtood by the uſe of the *Globe*.

And here in this place wee ſhall ſhew you only two the moſt common ſorts of Dials: one whereof is called an *Horizontall* Diall, becauſe it is deſcribed on a Plaine or flat, which is Parallel to the Horizon: and the other is called a *Mural*, as being erected, for the moſt part, on a Wall, perpendicular to the Horizon, and looking directly either toward the North, or South. But both theſe may not undidy bee called *Horizontall*; not in reſpect of the ſame place indeed, but of diverſe. And therefore whether it be a Flat Horizontall, or Erect, or elſe Inclining any way; there will be but one kinde of Artifice in making of the ſame.

Let us therefore now ſee in what manner a

plaine Horizontall Diall may be made for any place. Having therefore firſt prepared your flat Diall Ground Parallel to the Horizon, draw a Meridian on it, as exactly North, and South as poſſibly you can. Which done, draw another Eaſt and Weſt, which muſt croſſe it at right angles. The firſt of which lines will ſhew twelve, and the other ſixe of the Clocke, both morning and evening. Then making a Center in the Interſection of theſe two lines, deſcribe a circle on your Diall Ground to what diſtance you pleaſe: and then divide it, (as all other circles uſually are) into 360. parts. And it will not be amiſſe to ſubdivide each of theſe into leſſer parts, if it may conveniently bee done. And now it only remaines to finde out the diſtances of the Houre-lines in this circle, for any latitude of place. Which that we may doe by the uſe of the *Globe*, let it firſt be ſet to the latitude of the place aſſigned. And then make choice of ſome of the greater circles in the *Globe*, that paſſe through the Poles of the world; (as for example, the Æquinoctiall Colure, if you pleaſe:) and apply the ſame to the Meridian: in which ſituation it ſheweth midday, or twelve of the Clocke. Then turning about the *Globe* toward the Weſt, (if you will) till that fifteene degrees of the Æquator have paſſed through the Meridian: you muſt marke the degree of the Horizon that the ſame Colure Croſſeth in the Horizon. For that point will ſhew the diſtance of the firſt and eleventh houres from the Meridian. Both of

of which are diſtant an houres ſpace from the Meridian, or line of midday. Then turning againe the *Globe* forward, till other fifteene degrees are paſt the Meridian: the ſame Colure will point out the diſtance of the tenth houre, which is two houres before Noone, and of the ſecond houre after-noone. And in the ſame manner you may finde out the diſtances of all the reſt in the Horizon, allotting to each of them fifteene degrees in the Æquator croſſing the Meridian. But here you muſt take notice by the way, that the beginning of this account of the diſtances, muſt bee taken from that part of the Horizon, on which the Pole is elevated: to wit, from the North part of the Horizon, if the Arcticke Pole bee elevate; and ſo likewiſe from the South part, if the Antarcticke be elevated.

Theſe diſtances of the houres being thus noted in the Horizon of the *Globe*, you muſt afterward tranſlate them into your Plaine allotted for your Diall Ground, reckoning in the circumference of it ſo many degrees to each houre, as are anſwerable to thoſe pointed out by the Colure in the Horizon. And laſtly, having thus done, the Gnomon or Stile muſt bee erected. Where you are to obſerve this one thing (which is indeed in a manner the chiefe and onely thing in this Art to bee carefully looked unto) namely, that that edge or line of the Gnomon, which is to ſhew the houres by its ſhadow,

in all kinds of Dials must be set Parallel to the Axis of the world: that so it may make an Angle of Inclination with its plaine ground, equall to that which the Axis of the world makes with the Horizon. Now that the Stile is to stand directly to the North and South, or in the Meridian line, is a thing so commonly knowne, that it were to no purpose to mention it. And this is the manner of making a Diall on a plaine Horizontall Ground.

Now if you would make a plaine Erect Diall perpendicular to the Horizon (which is commonly called a *Murall*) and respecting either the North or South: you must remember this one thing: (the ignorance whereof hath driven those that commonly professe the Art of Dialling into many troubles and difficulties:) this one thing, I say, is to be observed: that that which is an Erect Diall in one place, will be an Horizontall in another place, whose Zenith is distant from that place 90. degrees, either Northward or Southward.

As for example: Let there be an Erect Diall made for any place whose latitude is 52. *gr.* this is nothing else, but to make an Horizontal Diall for the latitude of 38. degrees. And if there be an Erect Dial made for the latitude of 27. *gr.* the same will be an Horizontall Diall for the latitude of 63. degrees. The same proportion is to bee observed in the rest. And hence it manifestly appeares, that an Horizontall Diall and a Verticall are the same, at the latitudes of 45. degrees.

And

And ſo likewiſe by this rule may be made any manner of Inclining Diall, if ſo be that the quantity of the Inclination be but known. As for example, if a Diall be to be made on a plaine ground, whoſe Inclination is 10. degrees from the Horizon South-ward, and for a place whoſe latitude is 52. *gr.* Northward: you muſt deſcribe in that plaine an Horizontal Diall for the latitude of 62. degrees Northward. And if in the ſame latitude the Diall ground doe incline toward the North 16. *gr.* you muſt make an Horizontall Diall for the Northerne latitude of 36. *gr.*

And thus much ſhall ſuffice to have beene ſpoken of the making of Dials by the *Globe*.

52 y Latitude added to y angle of inclination 10 makes 62

substract 16 out of 62 y Latitude, & y remaind 46 is 36 Vide supra

The fifth and laſt Part.

Of the Rombes *that are deſcribed in the Terreſtriall* Globe, *and their uſe.*

THoſe lines which a Ship, following the direction of the Magneticall Needle, deſcribeth on the ſurface of the Sea, *Petrus Nonius* calleth in latine, *Rumbos*, borrowing the Appellation of his Countrymen the *Portugals*. Which word, ſince it is now generally received by learned Writers to expreſſe them by: we alſo will uſe the ſame.

Theſe *Rumbes* are deſcribed in the *Globe* either by greater or leſſer circles, or by certaine crooked winding lines. But Sea-men are wont to expreſſe the ſame in their Nauticall Charts by right lines. But this practiſe of theirs is cleane repugnant to the truth of the thing, neither can i by any meanes be defended from errours. The invention of *Rumbes*, and practiſe of deſcribing the ſame upon the *Globe*, is ſomewhat ancient. *Petrus Nonius* hath written much concerning the uſe of them, in two bookes which he intituleth, *de Navigandi ratione*. And *Mercator* hath alſo expreſſed

preſſed them in his *Globes*. But the uſe of them is not as yet ſo well knowne to every body: and therefore I think it not unfit, to be the more large in the explication of the ſame.

Beginning therefore with the nature and originall of them, we ſhall afterward deſcend to the uſe there is to be made of them in the Art of Navigation. And firſt we will begin with the originall, and nature of the Nautical Index, or Compaſſe: which is very well knowne to be of the faſhion of a plaine round Boxe, the circumference whereof is divided into 32. equall parts, diſtinguiſhed by certaine right lines paſſing through the center thereof. One point of it, which that end of the Needle that is touched with the Magnet alwaies reſpects, is directed toward the North; ſo that conſequently the Oppoſite point muſt neceſſarily reſpect the South. And ſo likewiſe all the other parts in it have reſpect unto ſome certaine fixed points in the Horizon: (for the Compaſſe muſt alwayes be placed Parallel to the Horizon.) Now I call theſe points Fixed, onely for doctrine ſake, not forgetting in the meane time that the Magneticall Needle, (beſides that it doth of it owne nature decline in divers places from the ſituation of the true Meridian, (which is commonly called, the variation of the Compaſſe) according to the cuſtome of divers Countries is alſo placed after a divers manner in the Compaſſe. For ſome there are that place it 5. *gr.* 37. *m.* more Eaſtward then that point that anſwereth to the North quarter

of

of the world: as doe the *Spaniards*, and our *Englishmen*. Some place it 3. *gr.* and almost 18. *m.* declining from the North; and some set it at 11. *gr.* 15. *minutes* distance from that point. All which notwithstanding, let us suppose the Needle alwayes to looke directly North and South. Now these lines thus expressed in the Mariners Compasse, are the common Intersections of the Horizon, and Verticall circles, or rather Parallel to these. Among which, that wherein the Needle is situate, is the common Intersection of the Horizon and Meridian. And that which crosseth this at right angles, is the common section of the Horizon, and a verticall circle drawne through the Æquinoctiall East and West. And thus we have the 4. Cardinall winds or quarters of the world, and the whole Horizon divi into 4. equal parts, each of them containing 90. degrees. Now if you divide again each of these into 8. parts, by 7. verticall circles, drawne on each side of the Meridian, through the Zenith: the whole Horizon will be parted into 32. equall sections: each of wch shall containe 11. *gr.* 15. *m.* These are the severall quarters of the world observed by Mariners in their Voyages: but as for any lesser parts or divisions then these, they look not after them. And this is the originall of the Nauticall Compasse, by which Sea-men are guided in their Voyages.

Let us now in the next place consider, what manner of lines a Ship, following the direction of the Compasse, doth describe in her course.

For

For the better understanding whereof, I think it fit to præmise these few Propositions: which being rightly and throughly considered, will make the whole businesse facile and perspicuous.

1 All Meridians of all places doe passe through both the Poles: and therefore they crosse the Æquator, and all Circles Parallel to it, at right angles.

2 If wee direct our course any other way then toward one of the Poles: we change ever and anon both our Horizon and Meridian.

3 The Needle being touched with the Loadstone, pointeth out the common Intersection of the Horizon and Meridian: and one end of it alwayes respecteth the North, in a manner, and the other the South. And here I cannot but take notice of a great errour of *Gemma Frisius*, who in his Corollary to the fifteene Chapter of *P. Appians* Cosmography, affirmes, that the Magneticall Needle respects the North Pole on this side of the Æquinoctiall line, but on the other side of the Æquinoctiall, it pointeth to the South Pole. Which opinion of his is contradicted by the experience both of my selfe, and others. And therefore, I beleeve, his too much credulity deceived him, giving credit perhaps to the fabulous relations of some vaine heads. But howsoever it be, the errour is a fowle one, and unworthy so great an Author. This frivolous conceit hath also beene justly condemned before, by the

the Illustrious *Iul. Scaliger*, instructed hereto out of the Navigations of *Ludovicus Vertomannus*, and *Ferdinand Magellane*.

4 The same *Rumbe* cutteth all the Meridians of all places at equall Angles, and respecteth the same quarters of the world in every Horizon.

5 A greater circle drawne through the vertex of any place, that is any whit distant from the Æquator, cannot cut diverse Meridians at equall angles. And therefore I cannot assent to *Pet. Nonius*, who would have the *Rumbes* to consist of portions of greater circles. For seeing that the portion of a greater circle, being intercepted betwixt diverse Meridians, though never so little distant from each other, maketh unequall angles with the same, a *Rumbe* cannot consist of them, by the præcedent proposition. But this inequality of Angles is not perceived (saith he) by the sense, unlesse it bee in Meridians somewhat farre remote from one another. Be it so. Notwithstanding the errour of this Position is discoverable by art and demonstration. Neither doth it become so great a Mathematician, to examine rules of Art by the judgement of the sense.

6 A greater circle drawne through the Verticall point of any place, and inclining to the Meridian, maketh greater angles with all other Meridians, then it doth with that from whence it was first drawne. It therefore behoveth, that a line, which maketh equall

angles

angles, with diverse Meridians, (as the *Rumbes* doe) be bowed and turne in toward the Meridian. And hence it is, that when a Ship saileth according to one and the same *Rumbe*, (except it be one of the foure Principle and Cardinall *Rumbes*) it maketh a crooked Spirall line, such as we see expressed in the Terrestriall *Globe*.

7 The portions of the same *Rumbe*, intercepted betwixt any two Parallels, whose difference of latitude is the same, are also equall to each other. Therefore an equall segment of the same *Rumbe*, equally changeth the difference of latitude in all places. And therefore that common rule of Sea-men is true: that in an equall space passed in one and the same *Rumbe*, one of the Poles is equally elevated, and the other depressed. So that *Michael Coignet* is found to be in an errour, who out of some certaine ill grounded positions indeavoured to prove the contrary.

Out of the 4th Proposition there ariseth this Consectary; namely: That *Rumbes*, though continued never so farre, doe not passe through the Poles. For seeing that the same *Rumbe* is equally inclined to all Meridians; and all Meridians doe passe through the Poles: it would then follow, that if a *Rumbe* should passe through the Poles, the same line in the same point would crosse infinite other lines: which is impossible, because that a part of any Angle, cannot bee equall to the whole. Neither doth that, which we delivered in the last Proposition make any thing against this Consectary;

to

to wit, that betwixt any two Parallels of equall diſtance, equall portions of the ſame *Rumbe* may be intercepted; that ſo it ſhould thence follow, that the ſegment of any *Rumbe* intercepted betwixt the Parallel of 80. *gr.* of latitude and the Pole, is equall to a ſegment of the ſame *Rumbe* intercepted betwixt the Æquator and the Parallel of tenne *gr.* of latitude: and the reaſon is, becauſe the Pole is no Parallel. And therefore it was a true Poſition of *Nonius*, That the *Rumbes* doe not enter the Poles: although it was not demonſtrated with the like happy ſucceſſe. For hee aſſumes foundations contrary to the truth: as wee ſaid before. And *Gemma Friſius* alſo was miſtaken, when hee affirmed, in his *Append. ad* 15. *cap. Appian: Coſmogr.* that the *Rumbes* doe concurre in the Poles: which was the opinion alſo of ſome others who are therefore juſtly taxed by *Michael Coignet.*

Theſe things being well conſidered, it will be eaſie to underſtand, what manner of lines a Ship, following the direction of the Magnet, doth deſcribe in the Sea. If the forepart of the Ship, be directed toward the North or South, which are the quarters that the Magneticall Needle alwayes pointeth at: your courſe will bee alwayes under the ſame Meridian: becauſe, as wee ſhewed in our third Propoſition, the Needle alwayes reſpecteth the Interſections of the Horizon and Meridian, and is ſituate in the plaine of the

ſame

same Meridian. If the forepart of the Ship be directed to that quarter that the East and West *Rumbe* pointeth out: in your course you wil then describe either the Æquator, or a circle Parallel to it. For if at the beginning of your setting forth, your Zenith be under the Æquator, your Ship will describe an Arch or segment of the Æquator. But if your Verticall point be distant from the Æquator either Northward or Southward; your course will then describe a Parallel, as farre distant from the Æquator, as the latitude of the place is whence you set forward at first. As suppose our intended course to bee from some place lying under the Æquator, by the *Rumbe* of the East and West: we shall goe forward still under the Æquator. For by this meanes, as we goe on, we alwayes meet with a new Meridian, which the line of our course crosseth at right angles. Now no other line, besides the Æquator, can doe this: as appeares manifestly out of the Corollary of the first proposition. And therefore in this course our Ship must describe a portion of the Æquator. But if we steere our course by the East and West *Rumbe* from any place that lyeth besides the Æquator: we shall be alwayes under the same Parallel. For all circles Parallel to the Æquator, doe cut all the Meridians at right Angles, by the Corollary of the first Proposition. And although the fore part of the Ship alwayes respecteth the Æquinoctiall East or West, or intersection of the Æquator and Horizon;

yet

yet in our progreſſe we ſhall never come neare the Æquator, but ſhall keepe alwayes an equall diſtance from it. Neither ſhall we come at all thither, whether the fore part of our ſhip looketh; but ſhall keep ſuch a courſe, wherein we ſhall have ever and anon a new Meridian ariſing, which we ſhall croſſe at equall Angles, and ſo neceſſarily deſcribe a Parallel. But if our voyage be to be made under the *Rumbe* which inclineth to the Meridian: our courſe will then be neither in a greater nor leſſer circle, but we ſhall deſcribe a kind of crooked ſpirall line. For if you draw any Greater circle through the Vertex of any place, inclining to the Meridian, the ſame circle will croſſe the next Meridian at a greater angle, then it did the former: by the 6. propoſition. And therefore it cannot make any *Rumbe*: becauſe the ſame *Rumbe* cutteth all Meridians at equall Angles, by the fourth Propoſition And all the Parallels, or leſſer circles, doe croſſe the Meridians at right Angles, by the Corollary of the 1. Propoſition: and therefore they doe not incline to the Meridian.

Concerning thoſe lines which are made in Sea voyages by the direction of the Compaſſe and Magneticall Needle; *Gemma Friſius* in his appendix to the fifteene Chapter of *Appians Coſmography*, part 1. ſpeakes thus. *Verum hoc obiter annotandum, &c.* And (ſaith he) I think it not amiſſe to note this by the way, that the voyages on land doe differ very much from thoſe that are performed at Sea. For thoſe are

under-

understood to be performed by the greater circles of the Sphære, as it is rightly demonstrated by *Werinerus*, in his Commentaries upon *Ptolomy*. But the voyages by Sea are for the most part crooked: because they are seldome taken in a great circle, but sometimes under one of the Parallels; when the Ship steeres her course toward East or West: and sometime also in a greater circle: as when it saileth from North to South, or contrariwise: or else under the Æquator, either direct East, or west; But in all other kinds of Navigations, the journeyes are Crooked, although guided by the Magnet, and are neither like to greater circles, nor yet to Parallels: nor indeed are circles at all, but onely a kind of crooked lines, all of them at length concurring in one of the Poles. Thus hee: and indeed very rightly in all the rest, save onely that he will have these lines to meet in the Pole: which, as we have already proved, is altogether repugnant to the nature of *Rumbes*.

Hitherto have we spoken of the originall and nature of *Rumbes*: let us now see what use there is of them in the Terrestriall *Globe*.

of

Of the uſe of Rumbes *in the Terreſtriall* Globe.

IN the Art of Navigation, which teacheth the way and manner how a Ship is to be directed in ſayling from one place to another, there are foure things eſpecially to be conſidered. And theſe are, the longitudes of the places, the latitudes, or differences of the ſame the *Rumbe*, and the ſpace or diſtance betwixt any two places, meaſured according to the practiſe uſed in Sea voyages. For the diſtances of places are meaſured by the Geographer one way, and by the Mariner another. For the former meaſureth the diſtances of places alwayes by greater circles; as after *Wernerus*, *Peucerus* hath alſo demonſtrated in his booke, *De Dimenſione Terræ*. But the Mariners courſe being made up ſometimes of portions of greater circles, and ſometimes of leſſer, but for the moſt part of crooked lines: it is good reaſon that hee ſhould meaſure the diſtances alſo of places by the ſame. Which, and how many of theſe are to be knowne before hand, that the reſt may be found out, comes in the next place to be conſidered. Now the places betwixt which our voyage is to bee performed, doe differ either in longitude onely, or in latitude only, or in both.

If they differ only in latitude, they are both under the ſame Meridian: and therefore it is

the North or South *Rumbe*, that the course is to be directed by. And there only then remaineth to know the difference of latitude, and distance betwixt these two places: One of which being knowne, the other is easily found out. For if the difference of latitude be given in degrees and minutes, as Sea-men are wont to doe, the number of degrees and minutes, being multiplyed by 60. (which is the number of English miles that we commonly allow to a degree, and that according to *Ptolomies* opinion, as we have already demonstrated:) the whole number of miles made in the voyage betwixt these places will appeare. And if you multiply the same number of degrees by seventeene and an halfe, you have the same distance in Spanish leagues. And so contrariwise, if the distance in miles or leagues be knowne, and you divide the same by 60. or seventeene and an halfe, the quotient will shew the number of degrees and minutes, that answer to the difference of latitude betwixt the two places assigned. As for example. If a man were to saile from the *Lizard* (which is the outmost point of land in *Corne-wall*) Southward, till he come to the Promontory of *Spaine*, which is called *C. Ortegall*; the difference of latitude of which places is 60. *gr.* 10. *minutes*: if you desire to know the distance of miles betwixt these places, multiply sixe *gr.* tenne *m.* by 60. and the product will be 370. the number of English miles betwixt the two places assigned. And this account may be much more truely

truely and readily made by our Engliſh miles, in as much as 60. of them are equivalent to a degree, ſo that one mile anſwereth to one minute: by which meanes all tedious and prolixe computation by fractions is avoyded.

In the next place let us conſider thoſe places that differ only in longitude: which if they lye directly under the Æquinoctiall, the diſtance betwixt them being knowne, the difference of longitude will alſo bee found: or contrariwiſe, by multiplication or diviſion, in like manner as the difference of latitude is found. But if they be ſituate without the Æquator, we muſt then goe another way to worke. For ſeeing that the Parallels are all of them leſſe then the Æquator, all of them decreaſing in quantity proportionably, till you come to the Pole, where they are leaſt of all: hence it comes to paſſe, that there can be no one certaine determinate meaſure aſſigned to all the Parallels. And therefore the common ſort of Mariners doe greatly erre, in attributing to each degree of every Parallel, an equall meaſure with a degree of the Æquator. By which means there have been very many errors committed in Navigation, and many whole Countryes alſo removed out of their owne proper ſituation, and tranſlated into the places of others.

That therefore there might bee proviſion made in this behalfe, for thoſe that are not ſo well acquainted with the Mathematiques: I have added a Table, which ſheweth, what pro-

portion a degree in every Parallel beareth to a degree in the Æquator: whence the proper measure of every Parallel may bee found. In which Table the first Colume proposeth the severall Parallels, each of them differing from other one degree of latitude. The second sheweth the minutes and seconds in the Æquator, that answer to a degree in each Parallel: which if you convert into miles, you shall know how many miles answer to a degree in every Parallel.

	M.	S.		M.	S.		M.	S.		M.	S.		M.	S.
1	59	59	27	53	27	50	38	34	71	19	31	90	0	0
2	59	57	28	52	58	51	37	46	72	18	31			
3	59	55	29	52	28	52	36	56	73	17	31			
4	59	51	30	51	57	53	36	6	74	16	31			
5	59	46	31	51	25	54	35	16	75	15	30			
6	59	40	32	50	52	55	34	24	76	14	28			
7	59	33	33	50	18	56	33	32	77	13	26			
8	59	25	34	49	44	57	32	40	78	12	24			
9	59	15	35	49	8	58	31	47	79	11	22			
10	59	5	36	48	32	59	30	53	80	10	20			
11	58	53	37	47	55	60	29	59	81	9	18			
12	58	41	38	47	17	61	29	5	82	8	16			
13	58	27	39	46	38	62	28	10	83	7	14			
14	58	13	40	45	58	63	27	14	84	6	12			
15	57	57	41	45	17	64	26	18	85	5	10			
16	57	40	42	44	35	65	25	22	86	4	8			
17	57	22	43	43	52	66	24	24	87	3	6			
18	57	3	44	43	8	67	23	26	88	2	4			
19	56	43	45	42	24	68	22	28	89	1	2			
20	56	20	46	41	40	69	21	30						
21	56	0	47	40	55	70	20	31						
22	55	37	48	40	9									
23	55	13	49	39	22									
24	54	48												
25	54	22												
26	53	55												

By

By the uſe of this Table, if a Ship have ſailed under any Parallel, and the ſpace be knowne how farre this Ship hath gone, the difference of Longitude may be found by the rule of proportion: and ſo contrarywiſe, if the difference of Longitude bee given, the diſtance will in like manner bee knowne. As for example. Suppoſe a Shippe to have ſet forth from *C. Dalguer*, (which is a Promontory on the Weſt part of *Africke*) and ſailed Weſtward, 200. Engliſh Leagues, that is to ſay, 600. miles. We deſire now to know the difference of Longitude betwixt theſe two places. That Promontory hath in Northerne latitude 30. degrees. Now to one degree in that Parallel anſwer 51. *m.* 57. *ſec.* that is to ſay, 51. miles, and fifty ſeven ſixtieth parts of a mile. Thus therefore we diſpoſe our proportionall tearms, for the finding of the difference of Longitude. 51. miles, 57. min. (or ſuppoſe 52. full miles, becauſe the difference is ſo ſmall) give one degree: therefore 600. give $11\frac{23}{52}$. gr. which is the difference of Longitude betwixt the place whence the Ship ſet forth, and that where it arived. But the tearmes are to be inverted, if the difference of Longitude be given, and the diſtance be to be ſought. But this is not ſo congruous. For we never uſe by the knowne Longitude to ſeeke the diſtance: but the contrary. Neither indeed have we as yet any certaine way of obſerving the difference of Longitudes; however ſome great boaſters make us large promiſes of the ſame. But,

Expectata seges vanis deludet avenis.

It remaineth now to speake of those places that differ both in Longitude and Latitude; wherein there is great variety, and many kinds of differences. Of all which there are foure (as we have already said) especially to be considered: and these are the differences of longitude, and of latitude, and the distance, and *Rumbe* by which the voiage is performed. Two of which being knowne, the rest may readily be found out. Now the transmutation of the things to be granted for knowne, and to be enquired after in these foure tearmes, may be proposed sixe manner of wayes, as followeth.

The difference of { Longitude and Latitude } being known: The { Rumbe and Distance } may also be found.

The difference of { Longitude and the Rumbe } being known: The { Difference of latitude and Distance } may be found.

The difference of { Longitude and Distance } being known: The { Difference of Latitude and Rumbe } may be found.

The difference of { Latitude and Rumbe } being known: The { Difference of longitude and Distance } may be found.

The difference of { Latitude and Distance } being known: The { Rumbe and Difference of longitude } may be found.

The { Rumbe and Distance } being known: the difference of { Longitude and Latitude } may bee found.

Thus

Thus you ſee that any two of theſe being knowne, the other two may alſo be found out. Now moſt of theſe (yea all of them, that are of any uſe at all) may be performed by the Globe. And let it ſuffice to have here given this generall advertiſement once for all.

Now beſide theſe things here already to be knowne: it is alſo neceſſary that we know the latitude of the place whence we ſet forth, and the quarter of the world that our courſe is directed unto: for otherwiſe we ſhall never be able rightly to ſatisfie theſe demands. And the reaſon is, becauſe that the difference of longitude and latitude is alwayes wont to be reckoned unto the two parts of the world: ſome of them to the North and South, and the reſt to the Eaſt and Weſt. And eſpecially, becauſe that from all parts of the Meridian, and from each ſide thereof, there are *Rumbes* drawne that are all of equall angles or inclinations. So that unleſſe the quarter of the world be knowne, whereto our courſe tendeth, there can be no certainty at all in our concluſions. As if the difference of latitude be to be enquired after: the ſame may indeed be found out; but yet we cannot determine, to which quarter of the world it is to be reckoned, whether North or South. And if we ſeeke for the difference of longitude: this may be found: but in the meane time we ſhall not know, whether it be to be reckoned toward the Eaſt or Weſt. And ſo likewiſe when the *Rumbe* is ſought for, we may perhaps find what incli-

nation it hath to this Meridian: but yet we cannot give it its true denomination, except we know toward what quarter of the world one place is distant from the other. For from each particular part of the Meridian, the *Rumbes* have equall inclinations. These grounds being thus laid, let us now proceed to the examination of each particular.

I. *The difference of Longitude and Latitude of two places being knowne, how to find out the* Rumbe *and Distance of the same.*

TVrne about the Globe, untill that some *Rumbe* or other do crosse the Meridian, at the latitude of the place whence you set forth. Then againe turne about either toward the East or West, as the matter shall require, untill that an equall number of degrees in the Æquator to the difference of longitude of the two places do passe the Meridian. Then afterward looke whether or no the aforesaid *Rumbe* doe crosse the Meridian at the latitude of the place, where you are: for if it doe so, you may then conclude, that it is the *Rumbe* you have gone by: but if otherwise, you must take another, and try it in like manner, till you light upon one that will do it.

As

As for example. *Serra Liona* is a Promontory of *Africke*, having in latitude 15. *gr.* 20. *m.* and in Northerne latitude 7. *gr.* 30. *m.* Suppose that we are to saile to the Isle of *Saint Helen*, which hath in longitude 24. *gr.* 30. and in Southerne latitude 15. *gr.* 30. *m.* I now demand, what *Rumbe* we are to saile by: and this we finde in this manner. I first apply to the Meridian the 356. *gr.* 40. *m.* of longitude: and withall observe what *Rumbe* the Meridian doth crosse at the latitude Northerne of 7. *gr.* 30. *m.* (which is the latitude of the place whence we are to set forth:) and I finde it to be the North norwest, and South southeast *Rumbe*. Then I turne about the Globe toward the West, (because *Saint Helens* is more Eastward then *Serra Liona*) untill that 9. *gr.* 10. *m.* in the Æquator (which is the difference of longitude betwixt these two places) do crosse the Meridian. And in this position of the Globe, I finde that the same *Rumbe* is crossed by the Meridian in the Southerne latitude of 15. *gr.* 30. *m.* which is the latitude of *Saint Helens* Isle. Therefore I conclude, that this is the *Rumbe* that we are to go by, from *Serra Liona* to *Saint Helens*. And in this manner you may finde the *Rumbe* betwixt any two places, either expressed in the Globe, or otherwise: so that the difference of longitude and latitude be but knowne.

If the places be expressed in the Globe betwixt which you seeke the *Rumbe*; you must then with your Compasses take the distance

betwixt

betwixt the two places assigned, and apply the same to any *Rumbe* that you please (but only in those places where they crosse the Parallels of latitude of the said places) til you find a *Rumbe*, whose portion intercepted betwixt the Parallels of the two places, shal agree to the distance intercepted by the Compasses. As for example. If you would know what a *Rumbe* leadeth us from *C. Cantin*, a Promontony in the West part of *Africke*; having in latitude 32. *gr.* 20. *m.* to the *Canary* Islands, which are in the 28. *gr.* of latitude. First, you must apply the distance intercepted betwixt the two places to any *Rumbe*, that lyeth betwixt the 28. and 32. *gr.* 30. *m.* of latitude, which are the latitudes of the places assigned: and you shall find that this distance being applyed to the South South-west *Rumbe*, so that one foot of the Compasses be set in the latitude of 32. *gr.* 20. *m.* the other will fall on the 28. *gr.* of latitude in the some *Rumbe*. Whence you may conclude, that you must saile from *C. Cantin* to the *Canary* Islands by the South South-west *Rumbe*. There are some that affirme, that if this distance intercepted betwixt two places, be applyed to any *Rumbe* where they all meet together at the Æquator, the same may be performed. But these men have delivered unto us their owne errours, in stead of certaine rules. For suppose it be granted, that the portions of the same *Rumbe* intercepted betwixt two Parallels equidistant from each other, are also equall in any part of the *Globe*: yet notwithstanding

standing they are not to be measured by such a manner of extension. For the *Rumbes* that lye neare the Æquator, differ but little from greater circles: but as they are farther distant from it, so they are still more crooked, and inclining to the Meridian.

The *Rumbe* being found, wee are next to seeke the distance betwixt the two places. *Nonius* teacheth a way to doe this, in any *Rumbe*, by taking with your Compasses the space of 10. leagues, or halfe a degree. Others take 20. leagues, or an whole degree. But I approve of neither of these, nor yet reject either. Only I give this advertisement by the way: that according to the greater or lesse distance of the places from the Æquator, a greater or lesse measure may be taken. For neare the Æquator, where (as we have said) the *Rumbes* are little different from greater circles; you may take a greater measure to goe by. But when you are farre from the Æquator, you must then take as small a distance as you can: because that here the *Rumbes* are very crooked. And yet the distance of places may be much more accurately measured, (so that the *Rumbe* and difference of latitude of the same bee but knowne) by this Table here set downe: which is thus.

In

In use

Rumbes	Degr.	Min.	Sec.	
First	1	1	10	
Second	1	4	56	Answer to a
Third	1	12	9	degree in the
Fourth	1	24	51	Æquator, or
Fifth	1	47	59	Meridian.
Sixth	2	36	47	
Seventh	5	7	33	

In this Table you have here set downe, how many degrees, minutes, and seconds in in every *Rumbe*, do answer to a degree in the Meridian or Æquinoctiall. Now a Degree (as we have often said,) containeth 60. miles: so that each mile answereth to a minute, and the sixtieth part of a mile, or seventeene paces, to every second. So that by the helpe of this Table, and the rule of proportion, the distance of any two places in any *Rumbe* assigned (if so be that their latitudes be known) may easily be measured: and so on the contrary, if the distance be knowne, the difference of latitude may be found. As for example. If a Ship have sailed from *C. Verde*, in *Africke*, lying in the 14. *gr.* 30. *m.* of Northerne latitude, to *C. Saint Augustine* in *Brasile*, having in Southerne latitude 8. *gr.* 30. *m.* by the *Rumbe* of Southwest and by South: and it be demanded what is the distance or space betwixt these two places. For the finding of this we dispose our tearmes of proportion after this manner. 1. *gr.* of latitude in this *Rumbe*, (which is the third from the Meridian)

dian) hath 1. *gr.* 12. *m.* 9. *ſec.* that is to ſay, $72\frac{8}{10}$ miles: therefore 23. *gr.* (which is the difference of latitude betwixt *C. Verde* and *C. Saint Auguſtine*) require 1659. miles and almoſt an halfe, or ſomething more then 553. Engliſh leagues. So that this is the diſtance betwixt *C. Verde* and *C. Saint Auguſtine*, being meaſured in the third *Rumbe* from the Meridian.

II. *The* Rumbe *being knowne, and difference of longitude; how to finde the difference of latitude and diſtance.*

TO find out this, you muſt turne the Globe, till you meete with ſome place, where the ſaid *Rumbe* croſſeth the Meridian at the ſame latitude that the place is of, where you ſet forth. And then turning the Globe either Eaſtward or Weſtward, as you ſee cauſe, untill that ſo many degrees of the Æquator have paſſed the Meridian, as are anſwerable to the difference of longitude betwixt the two places; you muſt marke what degree in the Meridian the ſame *Rumbe* cutteth. For that degree ſheweth the latitude of the place, you are arived.

As for example. The Iſle of *Saint Helen* hath in longitude 24. *gr.* 20. *m.* and in Southerne

therne latitude 15. gr. 30. m. Suppose therefore a Shippe to have sailed West North-west, to some place that lyeth West from it 24. degrees. We demand what is the latitude of this place. First therefore we set the Globe in such sort, as that this *Rumbe* may crosse the Meridian at the 15. gr. 30. m. of Southerne latitude, which is the latitude of *Saint Helens*: and this will happen to be so, if you apply the 37. gr. of longitude to the Meridian. Then we turne about the Globe Eastward, till that 24. gr. of the Æquator have passed under the Meridian. And then marking the degree of the Meridian, that the same *Rumbe* crosseth, we finde it to be about the 5. gr. 30. m. of Southerne latitude. This therefore we conclude to be the latitude of the place where we are arived.

And by this meanes also the distance may easily be found, if the *Rumbe* and difference of latitude be first knowne.

III. The

III. *The difference of Longitude and diſtance being given; how to finde the* Rumbe, *and difference of Latitude.*

THere is not any thing in all this Art more difficult and hard to bee found, then the *Rumbe* out of the diſtance and diſference of LONGITUDE given. Neither can it bee done upon the GLOBE, without long and tedious practiſe, and many repititions and menſurations. The practiſe hereof being therefore ſo prolixe, and requiring ſo much labour: it is the leſſe neceſſary, or indeed rather of no uſe at all. And the reaſon is, becauſe the difference of LONGITUDE, as wee have already ſhewed, is ſo hard to bee found out. The invention whereof I could wiſh our great boaſters would at length performe: that ſo wee might expect from them ſomething elſe, beſides bare words, vaine promiſes, and empty hopes.

Some

Some of these conclusions also which we have here set downe, are, I confesse, of no great use or necessity, out of the like supposition of the difference of latitude. Notwithstanding, for as much as the practise of them is easie & facile, I have willingly taken the paines, for exercise sake onely, to propose them.

IV *The difference of latitude and Rumbe being given, how to finde the difference of longitude and distance.*

FIrst set your Globe so, as that the *Rumbe* assigned may crosse the Meridian at the same latitude that the place is of, whence you set forth. And then turne about the Globe toward the East or West, as neede shall require, till that the same *Rumbe* shall crosse the Meridian at the equall latitude of that place whither you have come. And so marking both places, reckon the number of degrees in the Æquator, intercepted betwixt both their Meridians. And this shall be the difference of longitude betwixt the same places. As for example. *C. D'alguer* in *Africke* hath about 30. *gr.* of Northerne latitude, From whence suppose a Ship to have sailed North-

West and by West, to the thirtie eight *gr.* of Northerne latitude also. Now wee demand, what is the difference of longitude betwixt these two places? Turning therefore the *Globe*, till the Meridian crosse the said *Rumbe* at the thirtieth *gr.* of Northerne latitude, (which will bee, when the seventh *gr.* of longitude toucheth the Meridian,) I turne it againe toward the East, untill such time as the Meridian crosseth the same *Rumbe* in the thirtie eighth *gr.* of Northerne latitude: which will happen, when the three hundred fiftie second *gr.* of longitude commeth to the Meridian. Whence wee conclude, that the place where the Shippe is arived, is Westward from *C. D'alguer* about fifteene degrees. And the Meridian of that place passeth through the Easterne part of Saint *Michaels* Island, one of the *Azores*. Now how the distance may be found, the *Rumbe* and difference of latitude being knowne, hath beene declared already in the first proposition.

V. *The difference of Latitude, and diſtance being given, the* Rumbe *and difference of longitude may be found.*

THe *Rumbe* may eaſily be found out, by the Table which we have before ſet downe. But an Example will make the matter more cleare. If a Ship have ſailed from the moſt Weſterne point of *Africke*, commonly called *C. Blanco*, (which lyeth in the 10. *gr.* 30. *m.* of Northerne latitude) betwixt North and Weſt, for the ſpace of 1080. miles, and to the 20. *gr.* 30. *m.* of Northerne latitude alſo: and it be demanded, by what *Rumbe* this courſe was directed: for anſwer hereof, we proceed thus. The difference of latitude is 10. *gr.* and the diſtance betwixt theſe places 1080. miles: We therefore diſpoſe our tearmes thus, 10. *gr.* containe 1080. miles: therefore 1. *gr.* containeth 108. miles. Which if we divide by 60. we ſhall finde in the quotient 1. *gr.* 48. *m.* which number if you ſeeke in the Table, you ſhall finde it anſwering the fifth *Rumbe*. Neither is the difference betwixt that number in the Table, and this here of ours above one ſecond ſcruple. So that we may ſafely pronounce, that this voyage was performed by the fift *Rumbe* from the Meridian, which is North weſt and by weſt.

Now

Now the *Rumbe* being found, and the difference of latitude knowne, you may finde out the difference of longitude by the second proposition.

VI. *The* Rumbe *and distance being given, the difference of Longitude and Latitude may also be found.*

THis also may easily be performed, by the help of the former Table. And therefore wee will only shew an example how it is to bee done. From the *Cape of good Hope*, which is the most Southernly point of *Africa*, and hath in Southerne latitude about 35. degrees, a Ship is supposed to have sailed North North-west (which is the second *Rumbe* from the Meridian) above 642. miles; or if you will, let it be full 650. Now we demand the difference of latitude betwixt these two places: and this is found after this manner. First, we take the degrees and minutes that answer to a degree of latitude in the second *Rumbe*, and turne them into miles. And then we finde the number of these to be 64. miles 56. minutes, for which let us take full 65. miles. Now therefore our tearmes are thus to be disposed: 65. miles answer to 1. degree of latitude: therefore 650. will be equivalent to ten degrees of latitude.

Which if you substract from 35. (which is the latitude of the place, whence the Shippe set forth) because the course tends toward the Æquator: the remainder will be 25. *gr.* of Southerne latitude: which is the latitude of the place, where the Ship is arived.

Now the *Rumbe* being knowne, and the difference of latitude also found; the difference of longitude must be found out by the second Proposition.

FINIS.

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